1974

Economic implications of technological change in the wood products industry of Montana

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ECONOMIC IMPLICATIONS OF TECHNOLOGICAL CHANGE IN THE WOOD PRODUCTS INDUSTRY OF MONTANA

by

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Bachelor of Science, University of Montana, 1973

Presented in partial fulfillment of the requirements for the degree of

Master of Science in Forestry

UNIVERSITY OF MONTANA

1974

Approved by:

Co-Chairman, Board of Examiners

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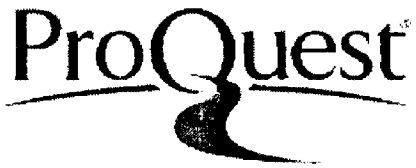
Dean, Graduate School

Jan 10, 1975

Date



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ACKNOWLEDGEMENTS

The author would like to take this opportunity to thank the U. S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station for the financial support provided for this study.

The study would not have been possible without the time and information furnished by the management of cooperating wood products firms. We thank them for this cooperation.

I am grateful to Maxine Johnson, Dennis L. Schweitzer, Leo K. Cummins and Robert F. Wambach for their comments and constructive criticism of the manuscript. Special thanks is extended to Richard E. Shannon and James L. Faurot, co-chairmen of the examining committee, for their help, guidance and support throughout the study.

A special thanks to my wife, Cheri, for helping make my graduate program possible.

Sutherland, Christopher B., M.S., 1975 Forestry

Economic Implications of Technological Changes in the Wood Products Industry in Montana (166 pp.)

Director: Dr. Richard E. Shannon

The purpose of this study was to relate some of the major technological changes that have taken place in the wood products industry of Montana since 1950 to the state's economy and forest resources. Sectors within the industry reviewed in the study were the plywood, particleboard, pulp and paper and sawmill and planing mill sectors.

Personal interviews were conducted by the author in the summer and fall of 1973 with managers of twenty-nine wood products firms. These firms produced approximately 69 percent of Montana's 1971 lumber production. Supplemental information was obtained from pertinent literature.

Conclusions reached as a result of this study include:

1) Technological innovations which are capable of boosting labor productivities higher percentages than forseeable production increases are now on the horizon in the sawmill and planing mill sector. Employment in this sector, as a result of this relationship, should level off and possibly decline.

2) The average labor productivity in Montana sawmills and planing mills was well below the achievements attained in mills interviewed in the study which invested in small log equipment.

3) The quantity of labor necessary to manufacture a given quantity of lumber since 1950 was closely related to total production. Less manpower was utilized per unit volume of output in years characterized by higher levels of production.

4) Although mill managers generally did not prefer lump sum sales to log scale sales, lump sum sales should always attain equal or better utilization when merchantability limits are not specified.

5) Large corporations will likely continue to expand their share of total wood product production. Three of these corporations (St. Regis, U.S. Plywood, and Burlington Northern) seem to have the added advantage of easier access to greater quantities of internally generated money and a more stable timber supply resulting from large acreages of their own timber.

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CHAPTER 1

INTRODUCTION

Technology is a term charged with polarity and omnipotence; it is at once the power to destroy and the power to save. Technology as used in this paper is a synonym for applied science which is neither inherently good nor bad in itself. When applied to a forest resource, the resultant impact of technology rests wholly upon the shoulders of those who apply it.

There have been sweeping changes in the technology of the wood products industry in Montana since 1950. Not only have there been substantial changes in the methods used to produce a given product such as lumber, but there are now completely new and different products. Before 1955, neither pulp and paper nor particleboard was being produced in Montana. These two sectors of the industry are particularly noteworthy because they provide useful and valuable products from wood residues that formerly provided little or no employment, income nor products of use to man.

Technological changes within a sector of the industry often do not result directly in an increase in employment. For example, the lumber sector uses less manpower to produce a given volume of

lumber today than in 1950. However, the technological changes that have occurred have made possible indirectly the manufacture and sale of a wider variety of wood products than in 1950, and hence made possible a net positive increase in wood products employment from a given volume of stumpage.

Technological changes in the different sectors of the industry thus have expanded Montana's effective timber supply base. These changes have made possible the utilization of larger proportions of the total wood fiber grown or available on a given area. More usable fiber per acre is particularly attractive in Montana where the acreage of forest land suitable for profitably growing continuous crops of timber for consumptive use is declining due to alternative uses which are incompatible with timber harvesting.

Objectives

The goal of this paper is to relate some of the major technological changes that have taken place in the wood products industry of Montana since 1950 and their influence upon the state's economy and forest resources. More specifically, the objectives of this study are to:

1. provide an understanding of the importance of the wood products industry to the economy of Montana,
2. determine the technological changes which have either

taken place or are likely to occur in the near future in the lumber, plywood, pulp and paper and particleboard sectors of Montana's wood products industry,

3. relate the actual and expected technological changes in these sectors to the economy and forest resources of Montana.

Study Methodology and Time Period

Much of the specific information concerning the present status of technology in Montana's wood products industry is not published in quantitative terms. It had to be collected directly from mill owners and managers. A letter explaining the objectives of this study and requesting personal interviews was sent to forty-seven firms representing approximately 89 percent of Montana's 1971 wood products production. Interviews beginning in July of 1973 and extending through November, 1973 were subsequently conducted with 29 cooperating firms representing approximately 69 percent of Montana's 1971 production. Additional information was obtained by oral and written communication with the mill owners and managers previously interviewed.

CHAPTER 2

MONTANA'S ECONOMY AND THE WOOD PRODUCTS INDUSTRY

In a period of time when most of the states' economies in this country are in the intensive attention ward, it appears that Montana's economy will be one of the last states to receive a bill of good health. As Johnson[1] (1972) has put it, "...Montana is in economic trouble." Since 1950, this state has experienced very limited economic growth. The economic growth that has taken place within the private sector can be substantially accounted for by contributions from the wood products industry.

Johnson's[2] recently completed study briefly describes Montana's economic growth. It documents the role of the wood products industry in that growth. The publication contains the most recent and complete information concerning the role of the wood products industry within the Montana economy.

The Economy of Montana

Income

The average, per capita income of Montanans is well below

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[1]Maxine Johnson, "Wood Products In Montana", Montana Business Quarterly 10 (Spring, 1972), p. 14.

[2]Ibid.

the average. The gap between Montana's per capita income and the national average has expanded measurably since 1950. In the period from 1950 to 1970, Montana's per capita income slipped from a position of 8 percent above the national average to 14 percent below the national average.[1] Cumulatively, the decline in relative national standing in per capita income in this period amounted to a 22 percent loss in per capita income for Montanans.

In 1969, eight counties[2] west of the Continental Divide recorded per capita incomes that were 9 percent lower than the average per capita incomes for Montana. Several reasons for this depression in western Montana per capita income were offered: 1) farmers and ranchers in western Montana, in general, are less prosperous than those in the eastern part of the state, and 2) there apparently was also a smaller proportion of the population at work in western Montana than for the state as a whole.[3]

Income Projections

In the Montana Economic Study,[4] per capita income is predicted to increase 31 percent for Montana as a whole and 37

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[1]Ibid., p. 14.

[2]These counties referred to are: Lincoln, Flathead, Sanders, Lake, Mineral, Missoula, Ravalli and Granite.

[3]Johnson, Montana Business Quarterly 10-21. p. 20.

[4]Montana Economic Study, Vol. 1, Chapter 1, Table 1.3, p. 1.21 and Vol. 3, Chapter 5, Table 5.3, p. 5.16 as cited by Johnson, Montana Business Quarterly 10-21.

percent for the eight counties of western Montana from 1969 to 1980. Despite the fact that these increases are substantial, they are still less than those predicted for the nation. Per capita income in Montana may be as much as 21 percent below the national average by 1980. The eight counties of western Montana previously mentioned may be as much as 25 percent below the national average.[1]

Employment

Total employment[2] in Montana has increased but at a much slower rate than the national average. An increase in total female employment in Montana offset a decrease in the total male employment.[3] The number of women at work in 1950 was so small compared to the number of men that the large rate of increase in female employment was barely enough to overshadow the much smaller rate of decrease in male employment. In the same period that Montana's employment grew 14 percent, total employment for the nation as a whole grew 33 percent.[4]

In terms of employment growth, the eight counties of western Montana were much more fortunate than eastern Montana.

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[1]Johnson, Montana Business Quarterly 10-21.

[2]As used here, employment refers to all non-military people at work in Montana fourteen years of age and older.

[3]Johnson, Montana Business Quarterly 10-14.

[4]Ibid., p. 14.

From 1950 to 1968, employment for the eight western counties increased 32 percent, which nearly equaled the national average.[1] Despite the fact that Montana did experience a 14 percent growth in employment, not enough new jobs were created to satisfy Montana's available work force. One indication of this deficiency in the creation of new jobs is the unemployment rate which usually averages about one percent higher than the national rate.[2] Another indication that Montana's economy simply did not provide enough jobs may be seen by looking at the net outmigration of residents (see figure 1). Forty-six counties experienced a loss in population, while only ten counties experienced population gains. Five of these ten counties were located in western Montana, where the large increases in employment occurred.

Employment Projections

Employment is anticipated in the Montana Economic Study (see Table 1) to continue to grow in the period from 1970 to 1980 and at a slightly faster rate than in the previous decade. From 1970 to 1980, employment in the eight western counties is anticipated to grow faster than for Montana as a whole but at a slightly slower rate than this region experienced during the 1960's. These

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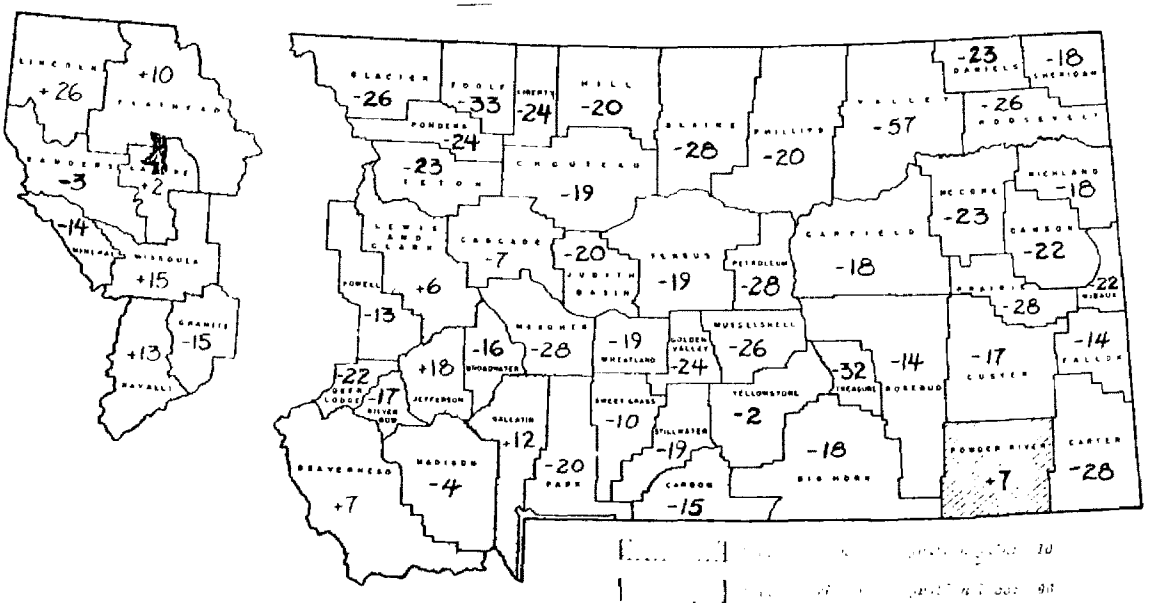
[1] Ibid., p. 19.

[2] Ibid., p. 16.

Figure 1. Net Migration Rates for Montana Counties, 1960-1970 (in Percentages).



Source: U.S. Bureau of the Census, *U.S. Census of Population: 1970, General Demographic Trends for Metropolitan Areas, 1960 to 1970, Montana*, PHC(2)-28 (Washington, D.C.: U.S. Government Printing Office, 1971), table 3, pp. 28-10 and 28-11.
Note: Migration rates measure the movement of persons into or out of an area during a specified period of time. Net migration is derived by subtracting the natural increase (births minus deaths) from the net change in population for the area. The migration rate is determined by expressing net inmigration or outmigration as a percentage of the total population at the beginning of the period. Thus, Missoula County's net migration gain for the 1960-1970 period was equal to 15 percent of its 1960 population.

Adapted and duplicated from Johnson, Montana Business Quarterly 10:16.

employment projections for western Montana assumed increases in the number of workers in mining, manufacturing (especially wood products) industries and federal government agencies, and a decrease in agricultural and railroad jobs.[1]

TABLE 1

CIVILIAN EMPLOYMENT

Location	1968	Projected 1980	Projected Change Number	Percent
Eight western counties	56,540	65,450	8,910	16
Montana	254,400	278,400	24,000	9

Source: Johnson, "Wood Products in Montana", Montana Business Quarterly 10:20, citing Montana Economic Study, Vol. 1, Chapter 1, Table 1.3, p. 1.21 and Vol. 3, Chapter 5, Table 5.3, p. 5.16.

Composition of Montana's Industries

A look at the changes in the composition of Montana's industries presented in Table 2 helps explain the slow growth in employment and income in Montana. Economists generally classify industries into two major categories: primary or export industries, and secondary or derivative industries. Primary industries produce goods and services that are usually consumed outside a state or region. Secondary industries produce goods and services that are

[1]Ibid., p. 20.

usually entirely consumed within a state or region. Due to the nature of the relationship between these industries, primary industries generally provide the basis for economic growth of a state or region and more specifically for the growth of the derivative industries within the boundaries of these areas.

TABLE 2

TOTAL CIVILIAN EMPLOYMENT IN MONTANA

	Annual Average		
	1950	1960	1970
Primary employment	103,300	86,600	83,800
Derivative employment	125,200	150,300	177,200
Total civilian employment	228,500	236,900	261,000
	Percent Change		
	1950-60	1960-70	1950-70
Primary employment	-16	-3	-19
Derivative employment	20	18	42
Total civilian employment	4	10	14

Source: Johnson, Montana Business Quarterly 10:15.

Between 1950 and 1970, the number of jobs in primary industries decreased by approximately 19,500 or about 19 percent. Increases in employment in the manufacturing and federal government sectors of the primary industries are all that kept this decline

in primary employment from being more severe. In this same period, Montanans increased their demand for service-oriented derivative industries, and derivative employment increased 42 percent above 1950 levels. This increase in derivative employment was so large that it more than offset the decline in primary jobs and total civilian employment was able to realize a 14 percent growth. The increase in employment in derivative industries which are generally lower paying, coupled with a decrease in the higher paying primary industries, explains much about why Montana's per capita income has fallen so far below the national average.

Summary of Montana's Economy

To the extent that employment and per capita income measure prosperity, Montana has not shared fully in the growth of national prosperity since 1950. To the extent that the predictions of the growth in employment and per capita income referred to in this paper are applicable, Montana can expect to suffer further setbacks relative to national economic growth from 1970 to 1980.

The Wood Products Industry

The wood products industry is and has been an important and integral part of the economy of this state and particularly of western Montana. Directly and indirectly this industry provides approximately 12 percent of the total employment and 11 percent

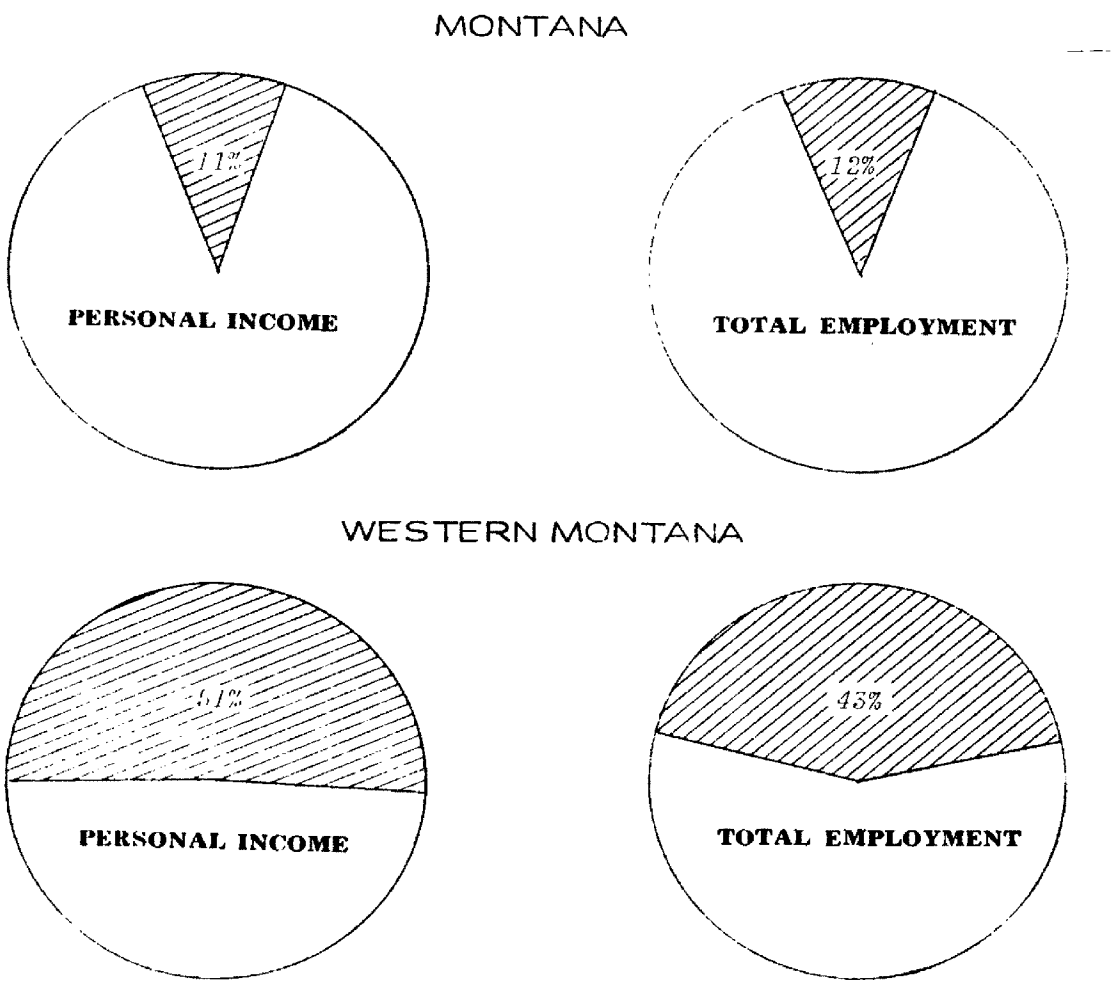
of total personal income in Montana (see figure 2). In the eight western counties of Montana, this industry directly and indirectly provides 43 percent of the total employment and 51 percent of the total personal income (see figure 2).

Earlier in this paper it was noted that primary employment increased in only two sectors: federal government and manufacturing. In the manufacturing sector, the wood products industry created 3,300 new jobs in the period between 1950 and 1970, more than all other manufacturing categories together (see Table 3).

The Role of the Wood Products Industry in the Growth of Montana Employment and Income

The relationship between primary and secondary industries, wherein jobs in the secondary industries are derived from jobs in primary industries, was discussed earlier in this chapter. The wood products industry, as a primary industry, indirectly supports jobs in secondary industries. Economists use what is called an employment multiplier to estimate the total number of jobs in an economy resulting from one job in a primary industry. These multipliers are not precise, but they do provide useful guidelines for making estimates. An employment multiplier for primary industries in Montana may be calculated by dividing the total employment in the state by the number of jobs in the primary industries. In following this procedure, an employment multiplier

Figure 2. Estimated proportion of total employment and total personal income directly and indirectly attributable to the wood products industry in Montana and eight western counties, 1969.



Sources: Estimated, using unpublished data from U.S. Department of Commerce, Office of Business Economics, Regional Economics Information System (Washington, D.C., February 1972); Steve Yurich, Regional Forester, U.S. Department of Agriculture, Forest Service, Region 1 (Missoula, Montana, February 1972); Harold C. Lynd, Associate State Director, U.S. Department of the Interior, Bureau of Land Management (Billings, Montana, January 1972); and Harold D. Roberson, Acting Assistant Area Director, U.S. Department of the Interior, Bureau of Indian Affairs (Billings, Montana, February 1972).

Notes: Total personal income includes income from participation in the labor force (wages and salaries, other labor income, and proprietors' income) plus property income and transfer payments. The eight western counties are Flathead, Granite, Lake, Lincoln, Mineral, Missoula, Ravalli, and Sanders. Includes the self-employed.

Adapted and duplicated from Johnson, Montana Business Quarterly, 10:32.

TABLE 3

PRIMARY EMPLOYMENT IN MONTANA

	Annual Average		
	1950	1960	1970
Agriculture	52,800	39,200	34,800
Mining	10,200	7,900	6,600
Manufacturing	18,000	20,600	23,900
Lumber, wood products, and paper	5,400	7,400	8,700
All other manufacturing	12,600	13,200	15,200
Railroads	14,000	9,000	6,600
Federal government, civilian	8,300	9,900	11,900
Total primary employment	103,300	86,600	83,800

	Percent Change		
	1950-60	1960-70	1950-70
Agriculture	-26	-11	-34
Mining	-23	-16	-35
Manufacturing	14	16	33
Lumber, wood products, and paper	37	18	61
All other manufacturing	5	15	21
Railroads	-36	-27	-53
Federal government, civilian	19	20	43
Total primary employment	-16	-3	-19

Adapted and duplicated from Johnson, Montana Business Quarterly 10:15.

industries. In following this procedure, an employment multiplier of 3.16 was obtained for Montana and 2.78 for the eight western counties (see Table 4). The multiplier of 3.16 means that for each additional job in a primary industry in Montana, an additional 2.16 jobs in secondary industries are created.

In the period from 1950 to 1970, an assessment of the contribution of the wood products industry to the growth in Montana's employment may be made by multiplying the 3,300 new jobs created in this sector by 3.16. The product, 10,248, equals the total number of new jobs in primary and secondary industries in Montana due to the expansion of the wood products industry. The creation of these jobs by this industry equals approximately 32 percent of the total 32,500[1] new jobs created in Montana from 1950 to 1970.

TABLE 4

EMPLOYMENT IN 1969

	Montana	Eight Western Counties
Total employment	273,870	59,029
Primary employment[a]	86,750	21,244
Employment multiplier	3.16	2.78

Source: Johnson, Montana Business Quarterly 10:31.

[a]Includes employment in agriculture, mining, manufacturing, railroads and the federal government.

[1]Ibid., p. 15.

If the 2.78 multiplier derived for the eight western counties is multiplied by the 3,500 new jobs created by the wood products industry out of a total of 13,780 new jobs in the area[1] between 1950 and 1968, the product equals 9,730 new jobs that directly and indirectly owe their origin to this industry. Using these figures, this employment contribution is equal to approximately 71 percent of the total new jobs that were created in this area from 1950 to 1968.

It should be noted here that the author who derived these multipliers felt that they were conservative and may slightly understate the contribution of the wood products industry to the economy of Montana.[2]

Summary of the Role of the Wood Products Industry In Montana's Economy

Future prospects of the wood products industry is of much interest to Montana because of current and past contributions to the economy of this state. In 1969, the manufacture of wood products provided approximately one-tenth of the total employment and income in Montana. The industry is of crucial importance to the welfare of the eight western counties, where it provided nearly one-half of the total employment and personal income in 1969. Not only

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[1] Ibid., pp. 15, 19.

[2] Ibid., p. 34.

is the industry important to Montana now, but it has also provided much of the impetus in helping the economy get as far as it has today. The wood products industry has often served to help bolster the state's sagging economy since 1950 by providing new jobs. In the period 1950 to 1970, it is estimated that the wood products industry can be credited with the creation of nearly one-third of all the new jobs in Montana. For a similar period, 1950 to 1968, in the eight western counties, it is estimated that slightly more than two-thirds of all the new jobs may owe their origin to the wood products industry.

Employment alone, relative to productivity, describes the impact of technological changes within the wood products industry as we have viewed the process.

What does the future hold for this industry? Will this industry be in a position to provide therapeutic assistance to Montana's economy as it has in the past. Or will it fade in importance as have many other primary industries? Chapter Three discusses timber supply, one of the strategic determinants of the possible future economic contribution of Montana's wood products industry.

CHAPTER 3

MONTANA'S TIMBER RESOURCE BASE

Montana, the "Treasure State", is indeed a land of bountiful resources and unexcelled beauty. John Steinbeck described Montana in the following manner:

> It seems to me that Montana is a great splash of grandeur. The land is rich with grass and color, the mountains are the kind I would create if mountains were ever put on my agenda. Montana seems to me to be what a small boy would think Texas is like from hearing Texans.[1]

Much of the beauty that Steinbeck saw in Montana's mountains must have been the forests, for they are truly one of the most common, though outstanding, features.

Blessed with unequaled exuberance, Strahorn constructed the following description in 1879 of a portion of Montana's forests:

> In Missoula County, you can ride for days at a time through yellow pine within four or five feet of each other, many towering up seventy-five feet to the first limb and being from three to five feet in diameter... Pine and cedar trees six feet in diameter and three hundred feet high are not rare in the Bonner lumber district along the Hell Gate River.[2]

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[1]Montana Forest Industries Committee, Montana's Forest Bounty, (Missoula, n.p., 1964), p. 3.

[2]Montana, The Resources of Montana Territory and Attractions of Yellowstone National Park, by Robert Strahorn (Helena: State of Montana, 1879), p. 8.

The dimensions of this particular resource may be expanded a bit beyond practical parameters in this account, but imagine the beauty of such a forest.

When viewed from a distance the forests often appear as a lush, dark blue carpet. This effect is created in part by sunlight filtering through aromatic hydrocarbons released by coniferous trees. A closer look at this carpet reveals not only the presence of some thirty-four native tree species[1] but also an explanation as to why many people reside in this state where their incomes are lower than the national average.

Montanan's derive more than important monetary income and employment from the fibers of this carpet. Hunting, fishing, hiking, picknicking, boating, skiing, prospecting and clean water are just a few of the many opportunities afforded Montanan's as a result of the presence of this carpet. Montanan's who either take advantage of these opportunities or who just take pleasure in knowing they exist, have a higher income than is commonly expressed in only monetary terms. The additional income is called psychic income, the subjective value of what individuals feel their surrounding environment is worth to them. People who say, "sure,

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[1]Forest Industries of Montana and American Forest Products Industries, Montana Forest Facts (Washington, D.C.: Forest Industries of Montana and American Forest Products Industries, 1962), p. 4.

I could make more somewhere else, but it's worth it to live in Montana", have found that their losses in monetary income have been overcome by compensating increases in psychic income. Forests are not the only type of psychic income, but they are a substantial contributor to such evaluations in western Montana where forests are most prevalent.

Acreages

Forests occupy approximately 23 million acres, or nearly one quarter of Montana's 93.3 million acres (Table 5). About three quarters of this forested area or 16 million acres is classified as commercial forest land which is generally available and suitable for growing continuous timber crops for consumptive uses.

Montana's total land area accounts for 4.1 percent of all the land in the United States (Table 5). The total acreage of commercial forest land in Montana constitutes 3.2 percent of the nation's total. Montana, then, is neither exceptionally rich nor poor in commercial forest land acreages.

Ownership

The public owns 71.4 percent of all commercial timberland in Montana (Table 6). The U.S. Forest Service alone manages 60.9 percent of all the land in this category. Public ownership of commercial forest land for the United States as a whole is much lower and amounts to only 27.2 percent.

TABLE 5

LAND AREAS IN MONTANA AND THE UNITED STATES BY LAND CLASS, JANUARY 1, 1970 AND LAND AREA OF MONTANA AS A PERCENT OF THE UNITED STATES
(Thousand Acres)

Land Class	Montana	U.S.	Montana as a % of U.S.[a]
Forest land	22,777	753,549	3.0
Commercial	15,983	499,697	3.2
Other	6,794	253,852	2.7
Other land	70,490	1,516,499	4.6
Total[b]	93,267	2,270,048	4.1

Source: U.S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States, Forest Resource Report No. 20 (Washington, D.C.: Government Printing Office, 1973), p. 226.

[a] derived

[b] figures may not add to totals because of truncating

TABLE 6

AREA OF COMMERCIAL TIMBERLAND IN MONTANA AND THE UNITED STATES BY OWNERSHIP
(Thousand Acres)

Ownership Class	Montana	Percent of Montana[a]	United States	Percent of United States[a]
National Forest	9,732	60.9	91,924	18.4
Other Public	1,685	10.5	44,196	8.8
Forest Industry	1,055	6.6	67,341	13.5
Other Private	3,510	22.0	296,235	59.3
Totals	15,982	100.0	499,696	100.0

Source: U.S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States, Forest Resource Report No. 20 (Washington, D.C.: Government Printing Office, 1973), pp. 232, 233.

[a]derived

As a result of this ownership pattern, the wood products industry in Montana is heavily dependent on publicly-owned timber for its survival. The management of these public lands, especially by the Forest Service who is responsible for the largest share of the commercial forest land in Montana, will determine largely the future supply of timber available to the industry in this state and hence the industry's existence.

Location

The forests of Montana are mostly situated in the western part of the state. A look at forest land in all of the ten counties west of the Continental Divide plus the adjacent counties of Lewis and Clark and Beaverhead as shown in Table 7 bears testimony to this locational aspect of the Montana forests. Nearly three-quarters of the land area in these counties is forested. One-half is commercial forest land.

These twelve counties are less than one-quarter of the total land in the state as shown in Figure 3 yet contain approximately two-thirds of all forest and commercial forest land in Montana.

The percentages of volumes in the different tree classes for Montana and the United States is given in Table 8. Saw timber trees constitute approximately 59.2 percent of all softwood volume in Montana's commercial forests, pole timber 27.1 percent and seedling and sapling 13.7 percent. In the United States, softwood

TABLE 7

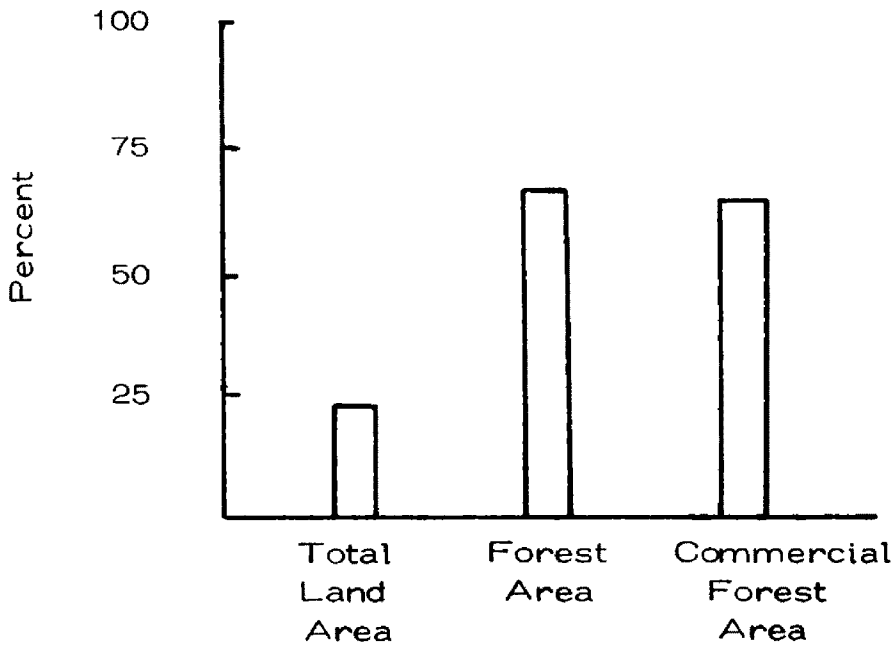
FOREST AREA IN SELECTED COUNTIES (Acres)

County	Land Area	Forest Area	Commercial Forest Area	Percent Forest Area[a]	Percent Commercial Forest Area[a]
Mineral	782,720	760,150	539,444	97.1	68.9
Sanders	1,799,040	1,455,481	1,108,694	80.9	61.6
Lincoln	2,377,600	2,268,676	1,845,865	95.4	77.6
Flathead	3,313,280	2,904,726	1,610,082	87.7	48.6
Missoula	1,682,560	1,464,402	1,193,795	87.0	71.0
Ravalli	1,525,760	1,235,825	544,156	81.0	35.7
Granite	1,098,880	805,894	648,574	73.3	59.0
Lake	960,000	536,646	444,879	55.9	46.3
Powell	1,495,680	960,763	546,554	64.2	36.5
Deerlodge	472,320	256,942	182,897	54.4	38.7
Beaverhead	3,555,840	1,060,554	862,997	29.8	24.3
Lewis & Clark	2,225,920	1,264,842	824,690	56.8	37.0
Total	21,289,600	14,974,901	10,352,627	70.3	48.6

Source: Forest Industries of Montana and American Forest Products Industries, Montana Forest Facts (Washington, D. C.: Forest Industries of Montana and American Forest Products Industries, 1962), p. 14.

[a]derived

Figure 3. Percentages of total Montana land area located in selected counties.[a]



Source: Forest Industries of Montana and American Forest Products Industries, Montana Forest Facts (Washington, D. C.: Forest Industries of Montana and American Forest Products Industries, 1962), p. 14.

[a]These counties include: Beaverhead, Deerlodge, Flathead, Granite, Lake, Lewis and Clark, Lincoln, Mineral, Missoula, Powell, Ravalli and Sanders. See map on page 8. These percentages were derived.

saw timber volume constitutes 74.9 percent of the total softwood volume, pole timber 20 percent and seedling and sapling 5.1 percent. Relative to the country as a whole, Montana has lesser percentages of wood volume in the saw timber class and greater percentages in the pole timber and seedling and sapling classes.

TABLE 8

PERCENTAGES OF NET SOFTWOOD VOLUME ON MONTANA AND UNITED STATES COMMERCIAL TIMBERLANDS BY TREE CLASS AND MONTANA TOTALS AS A PERCENT OF UNITED STATES TOTALS 1970

Class of Trees	Percent Volume Montana	Percent Volume U.S.	Montana Percent of U.S.
Saw timber	59.2	74.9	5.7
Pole timber	27.1	20.0	9.8
Seedling and Sapling	13.7	5.1	19.3
Total	100.0	100.0	7.2[b]

Source: U. S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States. Forest Resource Report No. 20 (Washington, D. C.: Government Printing Office, 1973), p. 249.

[a]Seedling and sapling volumes were derived from information in the above source and are suspect with regard to accuracy. Such volumes are extremely difficult to ascertain on a large scale and may also have been incorrectly derived.

[b]This percentage is a weighted average.

Almost two-thirds of the softwood growing stock volume in Montana, which includes all trees five inches in diameter at breast height and larger that are either currently or prospectively capable of being used for industrial roundwood, occurs on National Forest lands (see Table 9). The remaining one-third of the volume is owned by private non-industry (17.5 percent), other public agenices (9.0 percent) and the forest industry (7.4 percent).

The volume of commercial softwood growing stock increased on each of the ownerships in the period from 1952 to 1972. The average weighted volume increase for all owners was 7.9 percent which was 2.8 percent greater than the national average (see Table 9).

Softwood Volumes in Regional Perspective

Let us now place Montana and the United States in perspective with the Pacific Northwest, a major timber region which contains a substantial portion of the nation's standing softwood volume. The Pacific Northwest region (as used in this paper) encompasses only three states, Washington, Oregon, and Coastal Alaska. This region has a preponderance of volume in the saw timber class and averages nearly 10 percent more volume in that category than the rest of the nation as shown in Tables 8 and 10.

TABLE 9

NET VOLUME AND PERCENTAGES OF VOLUMES OF SOFTWOOD GROWING STOCK ON COMMERCIAL TIMBERLAND IN MONTANA BY OWNERSHIP, AND TOTALS FOR THE UNITED STATES AS OF DECEMBER 31, 1952 AND 1962, AND JANUARY 1, 1970
(Million Cubic Feet)

Ownership	Net Volume			Percent Owned[a]	Percent Change[a]
	1952	1962	1970	1970	1952-1970
National Forest	17,443	19,612	18,775	66.2	+7.6
Other Public	2,334	2,493	2,543	9.0	+9.0
Forest Industry	2,027	2,116	2,097	7.4	+3.5
Other Private	4,484	4,822	4,960	17.5	+10.6
Total Montana[b]	26,292	29,094	28,375	100.1	+7.9
Total U. S.	431,873	427,221	411,012	100.0	+5.1

Source: U.S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States, Forest Resource Report No. 20 (Washington, D. C.: Government Printing Office, 1973), p. 241.

[a]derived

[b]figures may not total correctly due to truncating

TABLE 10

PERCENTAGES OF NET SOFTWOOD VOLUME ON PACIFIC NORTHWEST COMMERCIAL TIMBERLANDS BY TREE CLASS AND PACIFIC NORTHWEST SOFTWOOD VOLUME AS A PERCENT OF U.S. SOFTWOOD VOLUME BY TREE CLASS

Class of Trees	Percent Volume PNW[a]	PNW Percent of U.S.[a]
Saw timber	83.3	44.6
Pole timber	12.9	25.9
Seedling and Sapling	3.8	29.9
Total	100.0	

Sources: Derived from U.S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States, Forest Resource Report No. 20 (Washington, D.C.: Government Printing Office, 1973), p. 249.

[a]The percentages in the saw timber and pole timber classes in these categories are respectively low and high because the minimum diameters for saw logs at breast height is two inches larger (11 inches) in the PNW than elsewhere in the U.S.

The softwood saw timber volume in this region comprises nearly one-half (44.6 percent) of the total such volume in the United States. The Pacific Northwest, therefore, has considerable influence upon the nation-wide supply of softwood saw timber products. Montana, on the other hand, with only 5.7 percent of the nation's softwood saw timber (see Table 8) has no such significance.

Compositionally, Montana has greater percentages of volume in the pole timber and seedling and sapling classes than the Pacific Northwest or the United States. In these classes, Montana does have a significant influence with 9.8 percent and 19.3 percent of the nation's total pole timber and seedling and sapling volumes respectively. Considering the volume in these categories, we can expect an abundance of industries specializing in the utilization of trees smaller than nine inches in diameter at breast height; or the expansion of such industries in the future. The possibilities and actualization of the development of such industries will be discussed in Chapter 4 of this paper.

Commercial Tree Species in Montana

Most softwood growing stock volume in Montana is either lodgepole pine (Pinus contorta var. latifolia) or Douglas-fir (Pseudotsuga mensiesii var. glauca Franco). Together, these two species constitute 60.9 percent of all softwood growing stock

volume in the state (see Table 11). Ponderosa pine (Pinus ponderosa), western larch (Larix occidentalis), Engleman spruce (Picea engelmanni), and the true firs (Abies spp.) are the other major softwood species in Montana and account for an additional 33.9 percent of the growing stock volume in the state.

The discriminative selection of particular species in past harvesting operations has changed the composition of species volumes. Ponderosa pine, western larch and lodgepole pine have been the primary recipients of past differential patronage by the wood products industry. The proportionate share of these species volumes in 1948 were estimated as follows: ponderosa pine, 23 percent; western larch, 22 percent; and lodgepole pine, 14 percent.[1] The share of the total volume consisting of ponderosa pine and western larch declined from 45 percent to 17 percent by 1970. They were heavily favored over many other species by industry. Lodgepole pine increased its share of the total volume 20 percent in the same period. It was harvested at a much slower rate than the more favored species.

Lodgepole pine and Douglas-fir are both considered good species for dimensional lumber and are also utilized by the pulp and paper and particleboard sectors of the industry.

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[1]Roy J. W. Ely, Montana's Production: 1930-1948; The Bureau of Business Research, Montana State University, Missoula Bulletin No. 12., p. 32.

TABLE 11

NET VOLUME OF SOFTWOOD GROWING STOCK ON COMMERCIAL TIMBERLAND IN MONTANA BY SPECIES AND PERCENT OF TOTAL REPRESENTED BY SPECIES
(January 1, 1970, Million Cubic Feet)

Category	Lodgepole pine	Douglas-fir	Spruce	Western larch	Ponderosa pine	True firs	Others	Total
Volume	9,544	7,738	2,479	2,426	2,377	2,364	14,449	28,376
Percent[a]	33.6	27.3	8.7	8.5	8.4	8.3	5.1	99.9

Source: U.S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States, Forest Resource Report No. 20 (Washington, D.C.: Government Printing Office, 1973), p. 268.

[a]derived

In addition to these uses, Douglas-fir is also the prime species for use in the manufacture of plywood in Montana. Because a majority of the volume in Montana is comprised of these two species, one would realistically expect the majority of the state's wood products industry to either have or develop the capability to utilize these species. Actual development of the wood product sectors is discussed in Chapter 4.

Productivity

The Rocky Mountain region of which Montana is a part, is the least productive timber growing section in the United States (Table 12). This section is not only producing the least volume growth per acre now (24 cubic feet), but also has a lower potential growth rate than any of the other regions. If we assumed that both the Rocky Mountain region and the Pacific Coast region were adequately stocked and were completely cleansed of all destructive forest agents, the Rocky Mountain region could produce only about two-thirds of the volume per acre that could be produced in the Pacific Coast region in the same amount of time.

The Rocky Mountain region has more room for improvement in timber growth, utilizing only 39.3 percent of its potential in 1970, than any other major region in the United States. The magnitude of improvement possible in this region, however, is not a fortress of strength in which to invest hope for the future. The same forces

TABLE 12

CURRENT AND POTENTIAL ANNUAL NET CUBIC FEET GROWTH PER ACRE BY SECTION

Section	1970 and Potential	All Ownerships	Percent of[a] Potentials	Percent of[a] Pacific Coast
North	1970	31	45.6	63.3
	Potential	68		68.7
South	1970	45	56.9	91.8
	Potential	79		79.8
Rocky Mountain	1970	24	39.3	49.0
	Potential	61		61.7
Pacific Coast[b]	1970	49	49.5	100.0
	Potential	99		100.0
All Sections	1970	38	50.0	77.6
	Potential	76		76.8

Source: Edward P. Cliff, 1973; Timber: The Renewable Material, The National Commission of Materials Policy; (U. S. Government Printing Office), pp. 2-37.

[a]derived

[b]exclusive of Alaska

which have led to this situation will not politely disappear in the future; just as this region is now typified by the lowest growth potential achievement, so will it be the last to attain its full potential. The major force centers around the investment of money. Many management activities necessary to attain maximum productivity, such as planting and precommercial thinning, are not free resources; the privilege of using them costs money. Public money allocated for the purpose of attaining full potential productivity on public lands is limited and, therefore, will rationally be invested in those acres which will return the greatest possible increases in productivity for every dollar expended for that purpose. The Rocky Mountain region, with the lowest potential productivity and consequently the largest percentage of low productivity area, will receive proportionately less investment money designated for expenditure in the improvement of productivity on public lands.

To the extent that Montana is representative of the Rocky Mountain region, similar problems may be encountered, but should not immobilize the efforts of Montana or the region to increase total growth. Good timber growing sites in both areas will compete equally well with good growing sites in other regions for investment money. Good sites in the National Forests of Montana comprise 23 percent of the total commercial forest land

in this ownership.[1] Approximately 29 percent of Montana's commercial timber land is in private ownership.[2] Much of this acreage is among the better timber growing sites in Montana and many of these owners may find the improvement of timber growth rates on their own lands an attractive investment. Also, activities such as commercial thinning may improve timber yield but do not require an investment. The abundance of small timber, generally contained in overstocked stands, will become economically feasible to commercially thin on a large scale basis as the demand for wood fiber increases. Just as the public land manager should maximize the volume of timber obtained from money spent for the purpose of increasing timber production, so does it behoove that manager to first attain the timber production possible with little or no investment.

Growth and Removal of Softwood Timber by Region

The growth and removal data of softwood growing stock volume for major geographic regions is shown in Table 13. In the United States, as in the Rocky Mountains, the net growth of softwood growing stock is greater than the volume being harvested. The only region where more growing stock has been harvested than grown on an annual basis is on the Pacific Coast. The practice of

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[1]Derived from U.S. Department of Agriculture, Forest Service, Region 1, Unpublished Data (Missoula, Montana, 1969).

[2]See Table 2.

TABLE 13

NET ANNUAL GROWTH AND REMOVALS OF SOFTWOOD GROWING STOCK BY SECTION (Billion Cubic Feet)

Section	Volumes 1952	1962	1970	Percent Change[1] 1950 to 1970
North:				
Net Growth	1.1	1.2	1.4	+27.3
Removals	.6	.6	.6	+ 0.0
South:				
Net Growth	3.6	4.5	5.4	+50.0
Removals	3.1	2.8	4.0	+29.0
Rocky Mountains:				
Net Growth	1.1	1.2	1.4	+27.3
Removals	.5	.7	.9	+80.0
Pacific Coast:				
Net Growth	2.0	2.3	2.6	+30.0
Removals	3.5	3.5	4.1	+17.1
Total, U. S.:				
Net Growth	7.8	9.3	10.7	+37.2
Removals	7.8	7.6	9.6	+23.1

Source: U.S. Department of Agriculture, Forest Service, The Outlook for Timber in the United States, Forest Resource Report No. 20 (Washington, D.C.: Government Printing Office, 1973), p. 26.

[1]derived

removing volumes in excess of annual net growth in this region has resulted in a decrease in the total volume of growing stock. This decrease in volume, however, does not necessarily adversely affect the capabilities of the residual growing stock to produce new volume; for instance, if old growth saw timber constituted the majority of volume in the growing stock class that was removed in excess of annual growth, younger, faster growing stock may more than make up the deficit. In the Pacific Coast region, net annual growth of softwood growing stock has increased 30 percent from 1950 to 1970 despite a reduction in the total volume in this class. In fact, all of the major regions experienced an increase in the net annual growth of softwood growing stock. The North and Rocky Mountain regions experienced the least increase in growth rate and the South the largest increase.

The Northern section was the only section of the nation that did not experience an increase in the removal of softwood growing stock during this period. Although large in percentage terms, the increase amounted to only .4 billion cubic feet which compares to increases of .5 billion cubic feet on the Pacific Coast and .9 billion cubic feet in the South. Nevertheless, this increase in timber removal, which Montana shared in as a part of the Rocky Mountain region, tells us that the growth of the wood products industry in Montana which was discussed in Chapter 2, was made

possible largely because of the increase in the removal of softwood growing stock volume.

Timber Removal From Montana Forests

The volume of timber removed from the Montana Forest from 1969 through 1973 is shown in Table 14 and Figure 4 by ownership. The total annual volume of timber harvested in Montana was relatively constant during this time span, ranging between 1.1 and 1.3 billion board feet per year. The three most significant suppliers to the timber harvest in 1973 were as follows: National Forests; 583.4 million board feet; private lands, 429.4 million board feet, and the Bureau of Indian Affairs, 98.0 million board feet. The combined contributions of the State and the Bureau of Land Management, the two remaining ownerships which sell timber to the wood products industry, amounted to 25.3 million board feet in 1973.

Declines in timber harvest during this period were most pronounced on National Forest lands where there was a reduction of 196 million board feet. Private lands were called upon to help offset this reduction and responded with the largest increase in the volume of timber harvested of any ownership, 67.2 million board feet. These increases were not sufficient, however, to offset the losses and so harvest volume in the aggregate declined. The extent to which this decrease in harvest may have affected

TABLE 14

REMOVALS OF TIMBER FROM MONTANA FORESTS
FOR SPECIFIED YEARS BY OWNERSHIP
(Million Board Feet)

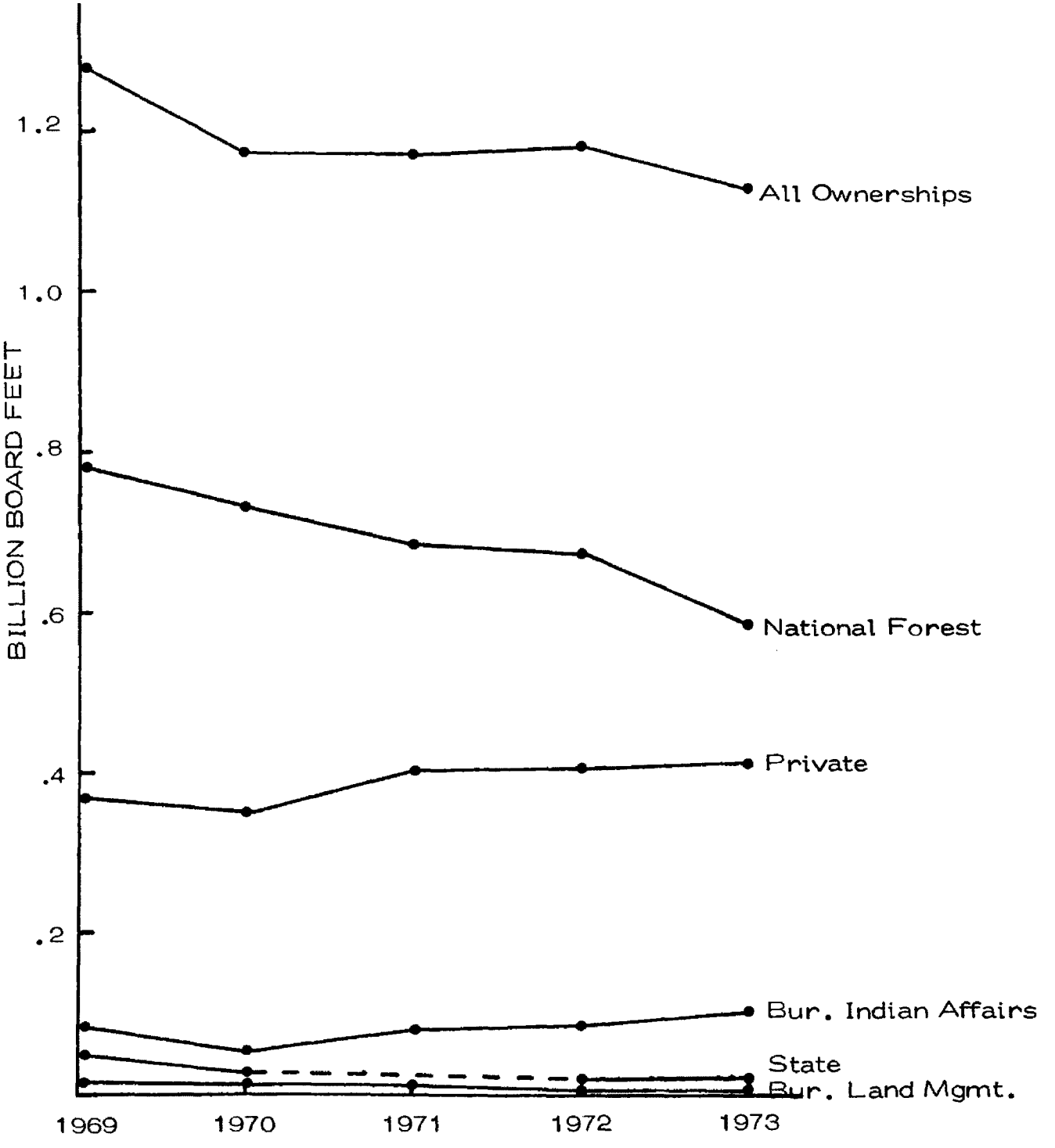
Source of Timber	1969	1970	1971	1972	1973
Private	362.2	343.1	402.1	406.6	429.4
State	46.7	28.2	---[a]	21.8	23.3
National Forest	778.0	731.9	683.5	676.2	583.4
Bureau of Land Management	16.5	15.3	12.0	4.3	2.0
Bureau of Indian Affairs	78.8	55.6	76.0	82.8	98.0
Total	1,282.2	1,174.1	1,173.6	1,191.7	1,136.1

Sources: U.S. Department of Agriculture, Forest Service, Region 1, unpublished data (Missoula, Montana); State of Montana Department of Forestry, unpublished data (Missoula, Montana); U.S. Department of the Interior, Bureau of Land Management, Public Land Statistics, (Washington, D.C.: Government Printing Office); interview conducted by telephone with Bureau of Indian Affairs office, Billings, Montana, October 10, 1974.

Note: Some of these figures were listed by calendar year and other by fiscal year.

[a]not available

Figure 4. Contributions to volume of timber harvested by ownership class for the years 1969 - 1973.



wood products output is not clear. It is clear however, from interviews conducted in this study, that improved utilization in the wood products industry helped reduce the impact of reduced timber harvest on the output of wood products.

The average percentage of the total volume of timber removed from the commercial timberlands of individual owners is relatively consistent with the percentages of the total volumes in those ownerships (see Table 15). This ratio was slightly less than one for the National Forest Lands and slightly more than one for private ownerships. Relative to the volume of commercial timber owned, larger percentages of the harvest came (1969-1973) from private lands than from national forests.

TABLE 15

PERCENTAGES OF TOTAL VOLUMES HARVESTED (Average 1969-73) AND OWNED (1970), BY OWNERSHIP CLASS

Ownership Class	Percent of Total Volume Removed	Percent of Total Volume Owned
Forest Service	57.9	66.2
Other Public	9.5	9.0
Private	32.6	24.9
Total	100.0	100.1

Sources: Derived from Tables 9 and 14.

On a sustainable annual basis more timber volume could have been made available from National Forest lands in Montana

than was harvested between 1969 and 1973. Unpublished data (1970) furnished by the Forest Service indicates (Table 16) that more volume can be made available in the future. The estimated annual allowable cut on industrial commercial National Forest lands in Montana for 1971 was approximately 891.6 million board feet (Table 16). Annual timber harvest from these lands averaged 690.6 million board feet in the period 1969 to 1973, 201 million feet less per year than the 1971 allowable cut. Declining National Forest timber volume sold relative to volume harvested may have caused some people to believe that there was a timber supply shortage in Montana. Whether or not this shortage existed is a matter of definition and perspective. Strictly speaking there was no shortage; more timber was available if the industry had been able to pay higher stumpage prices. Many people, for example, would have more than one car if cars were less expensive, but the fact that they can't afford several cars does not mean that there is a shortage of cars. To the wood products industry, however, there may have appeared to be a timber supply shortage. The quantity, the quality, and the location of the raw material supply was severely restricted by the reduced volume of timber offered for sale by the Forest Service. The volume of National Forest timber under contract but not harvested declined in four of the five years from 1969 to 1973 when the volume removed exceeded the volume of

TABLE 16

REGULATED ANNUAL ALLOWABLE CUT ON INDUSTRIAL COMMERCIAL FOREST LAND IN MONTANA BY WORKING CIRCLE
(Million Board Feet)

Working Circle	Industrial Volumes
Beaverhead	61.1
Bitterroot	40.1
Custer	10.4
Deerlodge	49.0
Flathead	173.6
Gallatin	48.0
Helena	32.7
Cabinet	34.0
Kaniksu	1.3
Kootenai	223.3
Lewis and Clark	24.1
Four Rivers	16.0
Mineral	60.0
Missoula	76.0
Thompson River	42.0
Total	891.6

Source: U.S. Department of Agriculture, Forest Service, Region 1, unpublished data (Missoula, Montana, 1970).

Note: Figures expressed above were separated from data for those working circles shared by Montana with other states by prorating Montana's share on the basis of percentages of the total volume of saw timber and pole timber in those working circles located in this state. Estimates of saw timber and pole timber volumes provided by Region 1, Forest Service, Missoula for the year 1969.

timber sold.

When the lumber market improves, the wood products industry and the Congress will both demand that the Forest Service narrow the gap between the allowable cut and the volume offered for sale. Unless the allowable cut is reduced by recalculation, the gap can be closed only by increasing the volume of timber offered for sale by the Forest Service.

In the future, Montana may further stretch the supply of wood resources by improving utilization standards. More wood products can and will be manufactured from a given timber resource by using logs with smaller top diameters, and logs with higher percentages of defective volumes. Much progress has been made in this direction and there are indications of more to come.

Summary

Montana has within her boundaries 6.6 percent of the total softwood growing stock volume in the United States, a relatively small but still important reserve of softwood growing stock. The existence of the wood products industry in Montana is heavily dependent upon publicly-owned timber. The public owns 75.2 percent ot total commercial growing stock within the state. When the lumber and plywood markets improve, there will be increased pressure for the removal of growing stock from these lands. These lands which have large volumes of timber (due in

large part to their extensive acreages) have not provided timber for harvest on a basis equal to their apparent growth capabilities in the recent past.

Given the available supply of wood fiber and all prospects for a continuing supply in the future, it can be assumed that this industry which has been so important to Montana in the past will continue to play a role in the State equal to or larger than the relative role that the products from wood fiber play within national economic life. To all apparent indications the national economic role of wood products will increase relative to other substitutable resources.

CHAPTER 4

DEVELOPMENT OF MONTANA'S WOOD PRODUCTS INDUSTRY

The wood products industry in Montana has always been dominated by the production of a single commodity, lumber. There were no particleboard or pulp and paper plants prior to 1955 in Montana and there was only one small plywood plant.

The First One Hundred Years, 1850-1950

The wood products industry, currently the largest manufacturing employer in Montana, had a very modest and early origin which predates Montana's existence as a state.[1] The first sawmill within Montana Territory began operating in the late 1840's. It was located near present day Stevensville in what is now Ravalli County. The sawmill was powered by water, and its saw consisted of a flattened wagon wheel with teeth cut into it.[2]

Expansion of the state's lumber industry seems to have proceeded quite slowly until about 1864. At this time, rapid expansion occurred. In 1863, Holter and Evenson established a

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[1]Montana was admitted to the Union in 1889 as the forty-first state.

[2]Arnold W. Bolle, "Forest Industries", Montana Almanac, Chapter 8, p. 217.

water-powered sawmill on the bank of the Ruby River in what is now Madison County. The mill was purchased second-hand in Denver. The mill's shafts were fashioned from iron wagon axles, and the belting was made from untanned oxen hides. No small amount of ordeal was incurred in establishing the mill in permanent residence in Montana. A team of oxen hauled the mill over one thousand miles and the mill had to be transferred to hand-sleds for the trek over the snow-covered mountain grades. The journey of the mill was said to have encountered further difficulties when it was involved in a holdup conducted by George "Clubfoot" Ives, the notorious bandit. The mill apparently survived the hardships of transport in good condition, and it produced five thousand board feet of lumber in its first year of operation.[1]

Missoula's first sawmill also began operation in 1864.[2] In either 1864 or 1865, a steam-powered sawmill operated by Coover and McAcdow began operations near Virginia City. This was considered to be the best mill in the Territory at that time.[3]

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[1]Department of Agriculture, Labor and Industry, Montana: Resources and Opportunities, (Helena: State of Montana, 1928), pp. 196-197.

[2]Arnold W. Bolle, "Forest Industries", Montana Almanac, Chapter 8, p. 217.

[3]A. M. Holter, "Pioneer Lumbering in Montana", in Contributions to the Historical Society of Montana (obtained through the Montana Building Dealers Association, Inc., n.d.),

The lumber produced by these early mills experienced little delay from the time of manufacture to sale. One source gives the following account:[1]

> "The demand for lumber was greater than supply and quite often some of the larger mining companies would send a spy out on the road, in order that they might be informed when a load of lumber was approaching. Then, they would have a crew of men arrive in the yard simultaneously with the load of lumber, and when the team stopped, without consulting me (Holter) at all, they would unload the lumber and carry it off to their mines. Soon a man would come to me with the pay for the lumber, and they always settled according to the bill of lading of the load at the established price and that no loss was incurred by this summary method of marketing."

The lumber shortage, which was particularly acute in mining communities, resulted in lumber prices that were many times greater than those of today expressed in current dollars. In 1864, lumber sold in Nevada City, Montana for $150 per thousand board feet. It was not specifically stated in this account, but this lumber was probably also green and unfinished.[2] In 1972, wholesale prices of dried and finished Number 2 Ponderosa Pine lumber

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Volume E, n.p., cited by William Elmer Anderson, "A Study of Lumber Retailers in Three Primary Wholesale-Retail Centers", (Master's Thesis, University of Montana, 1968).

[1] Ibid., p. 8.

[2] Ibid.

averaged $180 per thousand board feet, only $30 more than in 1864.[1]

The production of Montana sawmills exhibited a remarkable growth rate in the period 1864 to 1900. In 1869, sawmills produced 13 million board feet and by 1900 produced an estimated 250 million board feet of lumber,[2] an increase of nearly 20 times the 1869 production. Lumber production increased gradually and cyclically after 1900 (shown in figure 5) reacting to changes in lumber markets. In 1923, lumber production exceeded 400 million board feet, but nine years later production was barely over 100 million board feet, less than one fourth the 1923 totals. The large decrease in production was the result of depressed markets during the depression. Despite many peaks and valleys, lumber production climbed to a new high of 600 million board feet in 1948.

Lumber production apparently grew faster than demand resulting in a reduction in lumber prices. Increased efficiency of sawmills brought about by the introduction of such innovations as steam-power may have helped reduce lumber prices by reducing production costs. In 1879, rough lumber in Montana was selling

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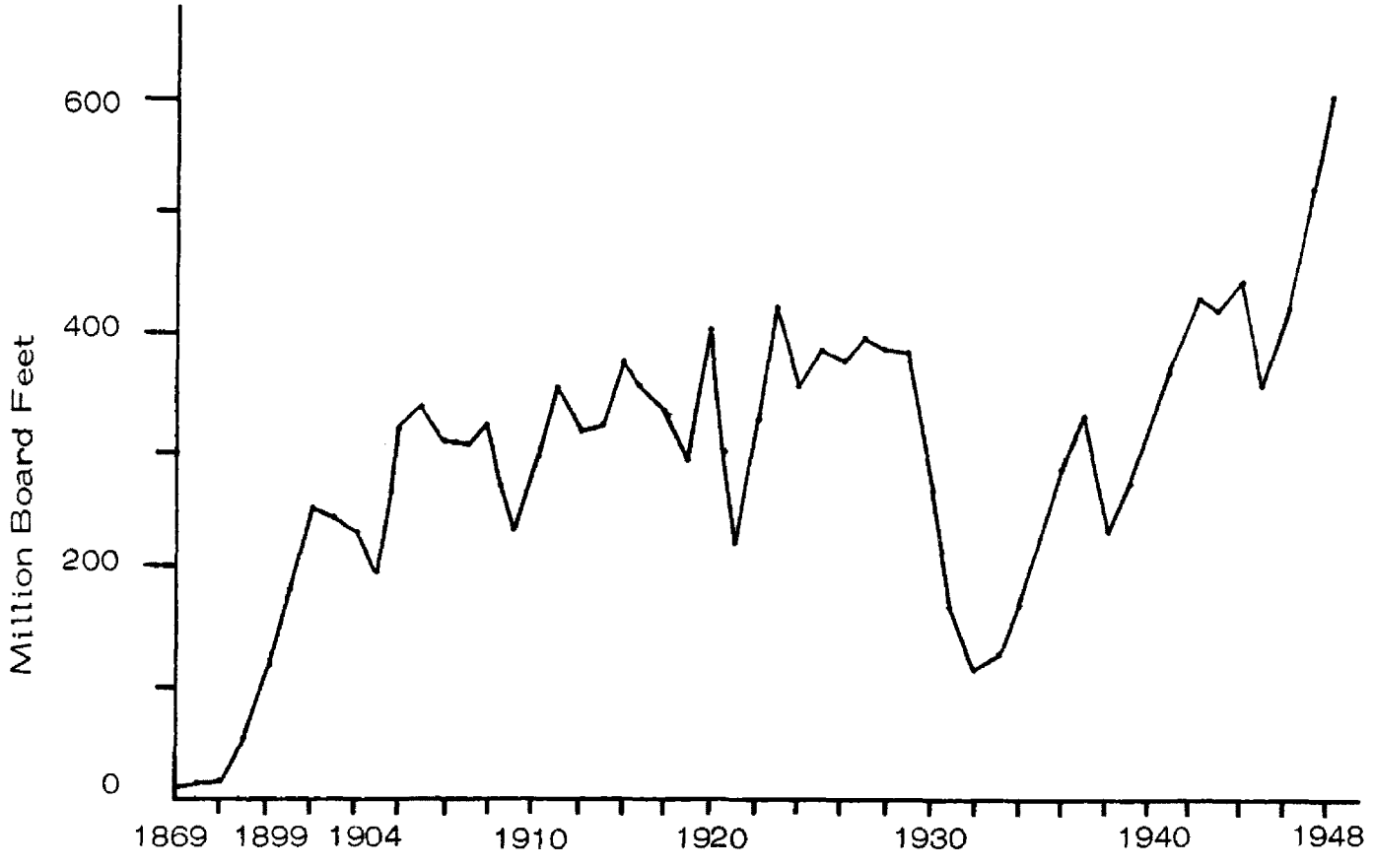
[1]U.S. Department of Agriculture, Forest Service, Production, Prices, Employment, and Trade in Northwest Forest Industries, Third Quarter, 1973, by Ed Holt, (Portland, Oregon: Pacific Northwest Forest and Range Experiment Station, 1973), p. 11 (3-1).

[2]U.S. Department of Agriculture, Forest Service, Forest Resources of Montana, by Blair Hutchison and Paul D. Kemp,

Figure 5. Annual lumber production Montana.



Source: U.S. Department of Agriculture, Forest Service, Forest Resources of Montana, by Blair Hutchison and Paul D. Kemp, Forest Resource Report No. 5 (Washington, D.C.: U.S. Government Printing Office, 1952), p 4.

for an estimated $20 to $25 per thousand board feet.[1] This is a sizable reduction from the $150 per thousand board feet that Holter had received fifteen years earlier, though there was probably considerable variation in lumber prices in different areas of the state. An indicator, and also a likely cause of this variation in prices, was the wage differential paid to sawmill workers in different areas of Montana. Sawyers in Missoula were paid $50 per month plus board, less than one-half the $125 per month plus board that sawyers in Helena earned.[2] There was more mining activity in Helena at the time, and the mills probably had to pay higher prices to compete successfully with the mines for labor. It follows that the mills in Helena who had to pay such high labor costs also would have had to charge considerably more for their products to stay in business.

In the period from 1864 to at least 1922, the market and subsequently the price of lumber products was heavily dependent upon the health of the mining industry. One source speaking about this dependence in 1914 found that "cutting of the forest for anything

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Forest Resource Report No. 5 (Washington, D.C.: U.S. Government Printing Office, 1952), p. 4.

[1]Robert Strahorn, The Resources of Montana Territory and Attractions of Yellowstone National Park, p. 8.

[2]Ibid.

but mine timbers is of relatively little importance".[1] In 1922, Butte's mines alone were consuming timber at the rate of 75 million feet of sawed timber per year.[2] This amount of lumber was roughly equal to one-third of the total lumber production in Montana at that time.

In the period from 1928 to 1952, the mining industry remained an important buyer of Montana lumber, but of less significance than in the period preceeding 1928. In 1928, Montana mines consumed one-fourth (89 million board feet) of the State's lumber production,[3] but by 1952 only one-fifth (120 million board feet) of total lumber production went to mining.[4]

Trends in Mill Size

Three major phases in the proportionate share of total lumber production accounted for by small, medium and large sawmills

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[1]O. W. Freeman, "Montana, A Study of the Geographic Factors Influencing the State", Bulletin of the Geographical Society of Philadelphia, Vol. XII, No. 4, 1914. (reprint), p. 159.

[2]Montana Association of Commercial Organization Secretaries, "Directory of Montana-Made Products", 1922, p. 245.

[3]Derived from Department of Agriculture, Labor and Industry, Montana: Resources and Opportunities, (Helena: State of Montana, 1928), pp. 166-167.

[4]U.S. Department of Agriculture, Forest Service, Forest Resources of Montana, by Blair Hutchison and Paul D. Kemp, Forest Resource Report No. 5, (Washington, D.C.: U.S. Government Printing Office, 1952), p. 31.

have been identified for the period extending from 1840 to 1948.[1] The first phase, characterized by small pioneer mills, began with the first mill in the 1840's and ended about 1890. In the second phase, from 1890 to about 1931, large mills, with an annual output in excess of ten million board feet per mill, accounted for nearly three quarters of Montana's total lumber production. There were never more than seven active large sawmills at one time during this second phase. The third phase, extending from 1931 to 1948, saw a dramatic change in the proportionate production of the various size mills. The percentage of lumber produced by large mills, with an annual output in excess of 10 million board feet, decreased from a high of 78 percent in 1931 to 35 percent in 1948. During this period, medium size mills, with an annual output of one to ten million board feet per mill, expanded their contributions to lumber production from 15 to 48 percent. Small mills, with an annual lumber output less than one million board feet per mill also enjoyed prosperity in the period, increasing their share of total output from 10 to 17 percent. (See figure 6 for a graphic presentation of these trends.)

Interpretation of Factors Influencing Trends in Mill Size

An examination of some of the factors that influenced mill

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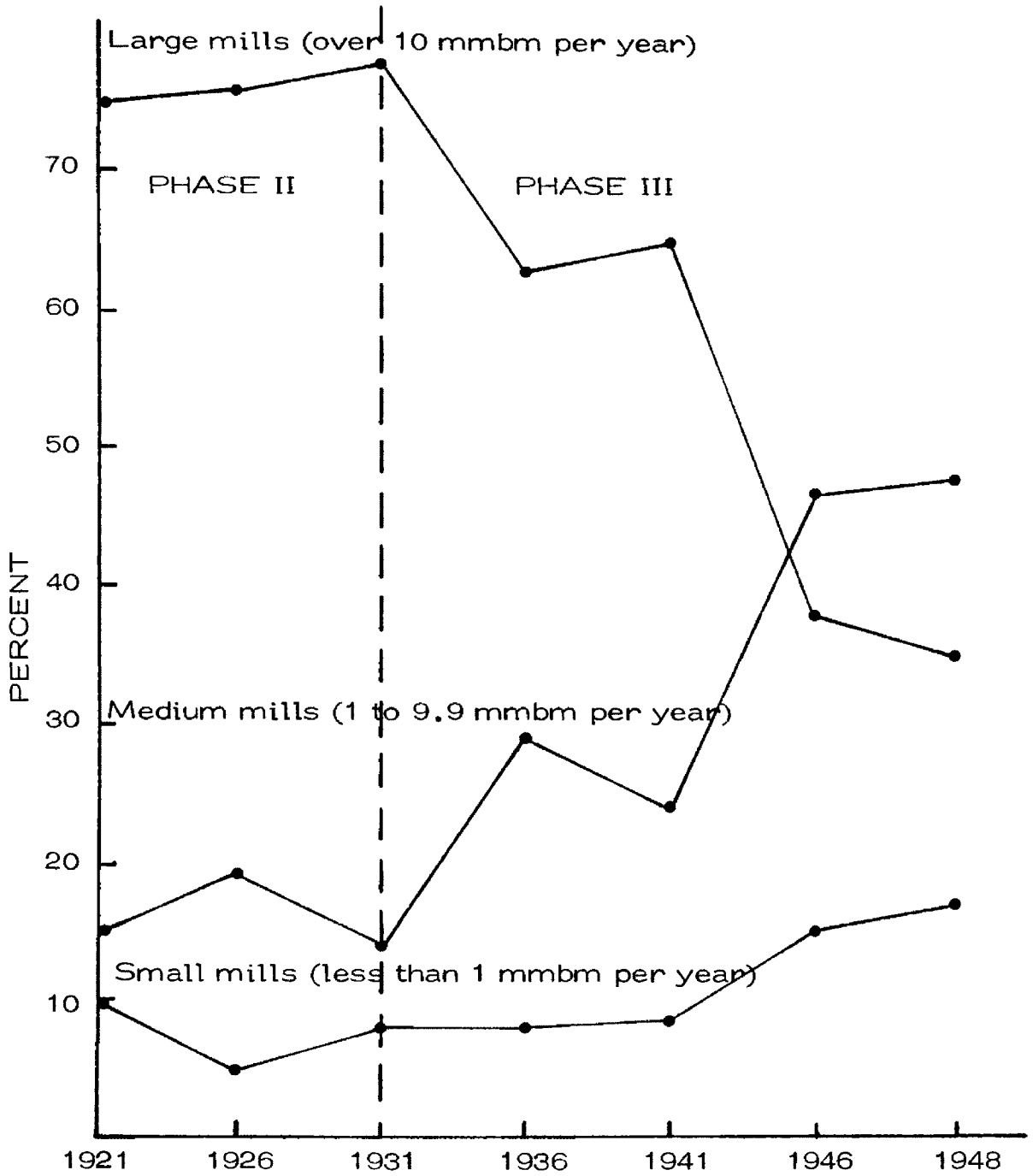
[1] Ibid., pp. 27-29.

Figure 6. Percentage of lumber produced in Montana by various mill sizes for specified years 1921 to 1948.



Source: U. S. Department of Agriculture, Forest Service, Forest Resources of Montana, by Blair Hutchison and Paul Kemp, Report No. 5, Washington, D.C.: U. S. Government Printing Office, 1952), p. 75.

size in the past may identify factors which will influence mill size in the future. These factors are not readily evident in the literature and many of the following explanations are little more than conjecture.

In the third phase, when the large mills' share of production was declining, the number of large mills decreased from seven to five. The two mills that closed apparently did so because of their inability to get enough ponderosa pine at a time when it was difficult to market lumber of other species.[1] The prices paid for ponderosa pine and western white pine were sufficient to justify shipment to markets outside Montana, while other timber species were simply not valuable enough to ship outside of local markets. The fact that ponderosa pine and western white pine accounted for 47 percent of all the lumber cut in the period from 1900 to 1948, even though these two species accounted for only an estimated 22 percent of the total saw timber stand, is evidence of the heavy emphasis placed on these two species.[2] The more successful large mills usually owned a large quantity of their own timberland which often included a large volume of ponderosa pine and had the additional advantage of a receptive market for less popular species such as Douglas-fir and

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[1] Ibid., p. 27.

[2] Ibid., p. 29.

western larch.[1]

The prosperity of the medium size mills is not easy to explain empirically, but some intuitive explanations may be helpful in understanding their success. First of all, firms in the industry faced a great deal of uncertainty. This uncertainty was embodied in the large fluctuations in the actual volume of lumber produced, as discussed earlier in this chapter. The great variation in actual production reflects both the lumber selling price and the availability of suitable raw materials at a price that would allow at least break-even profits. Under these unstable conditions, medium size mills which required less volume of raw material and which were capable of being installed at less cost than larger mills were a more rational choice for investment money.

Entry into the lumber industry was relatively free because of low capital investment requirements. Medium size mills required substantially less money and less time to build than their larger counterparts. As the market for Montana lumber grew, it was more expedient, both in terms of capital and time, to continue to build medium size mills. This same argument applies to small mills. In the period from 1921 to 1948, the number of small mills increased

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[1] Ibid., p. 29.

from 140 to 342. The 342 active small mills in 1948 were nearly 4 times the 87 medium size mills in operation at that time.[1] The production, however, of the 342 small mills was of such little magnitude that their large numbers were not enough to match the production of the medium size mills.

Many of the medium size mills were able to afford resaws and other mechanical aids that were common in larger mills.[2] As such, medium size mills possessed the efficiency and utilization capabilities of the large mills but with lower capital investment.

Diversity of mill location was another factor in favor of establishing medium and small mills. Medium and small mills could locate in areas closer to their raw material supply. No matter where the large mills would locate, because of the preponderance of input necessary for continuous operations they would either have to be very close to an enormous supply of timber or go greater distances than the other mills to procure their raw material requirements.

Small and medium size mills could also reduce their costs by building closer to their markets. Local markets in Montana were

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[1]U.S. Department of Agriculture, Forest Service, Forest Resources of Montana, by Blair Hutchison and Paul D. Kemp, Forest Resource Report No. 5, (Washington, D.C.: U.S. Government Printing Office, 1952), p. 75.

[2]Ibid., p. 29.

expanding in the period 1924 to 1945.[1] Small and medium mills best suited the needs of such markets. Large mills had to locate near sources of large quantities of suitable timber and near larger markets which could absorb their production.

The distribution of the most desired species at the time, ponderosa pine, was not conveniently located around the large mills. A small or medium mill could operate on a full-time basis near concentrations of ponderosa pine or other suitable species that were not present in large enough quantities to justify large mills.

The Post 1950 Era

The period following 1950 was characterized not only by rapid expansion of the lumber sector but also by great diversification of the entire wood products industry. This diversification produced an industry whose structure reflects little of its first one-hundred years. Montana's wood products industry added pulp and paper, plywood and particleboard sectors after 1950. Each of these non-lumber sectors represent a new type of technology in converting trees to wood products. The pulp and paper mill and the particle-board plants are particularly noteworthy because they have generated substantial monetary benefits from wood residues which previous to that time had no value.

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[1] Ibid., p. 30.

The Lumber Sector

Production

The output of sawmills and planing mills have exhibited remarkable growth since 1950 (figure 7). Lumber production increased from six-tenths of a billion board feet in 1950 to attain a peak production of 1.5 billion board feet in 1968. From 1969 through 1972, this sector never regained the 1968 production levels but did remain in this production vicinity, producing between 1.3 and 1.4 billion board feet each year. In the period from 1950 through 1972, lumber production grew 671 million board feet or an average of 29 million board feet per year. One of the most significant features of this growth was the complete absence of the large fluctuations that occurred prior to 1950 which included a 75 percent production reduction between 1923 and 1932 (largely the result of the depression). Until 1968, no production declines were sustained for more than two years before a production increase surpassed the previous peak output.

Numbers and Average Size

The number of mills has generally decreased since 1950 but the average size of the active mills has increased (Table 17). After the conclusion of World War II, the demand for wood products skyrocketed, creating a backlog of demand that was apparently not satisfied until 1957. During the period 1950 to 1956 the number of

Figure 7. Lumber production: 1950 - 1972 (billion board feet)

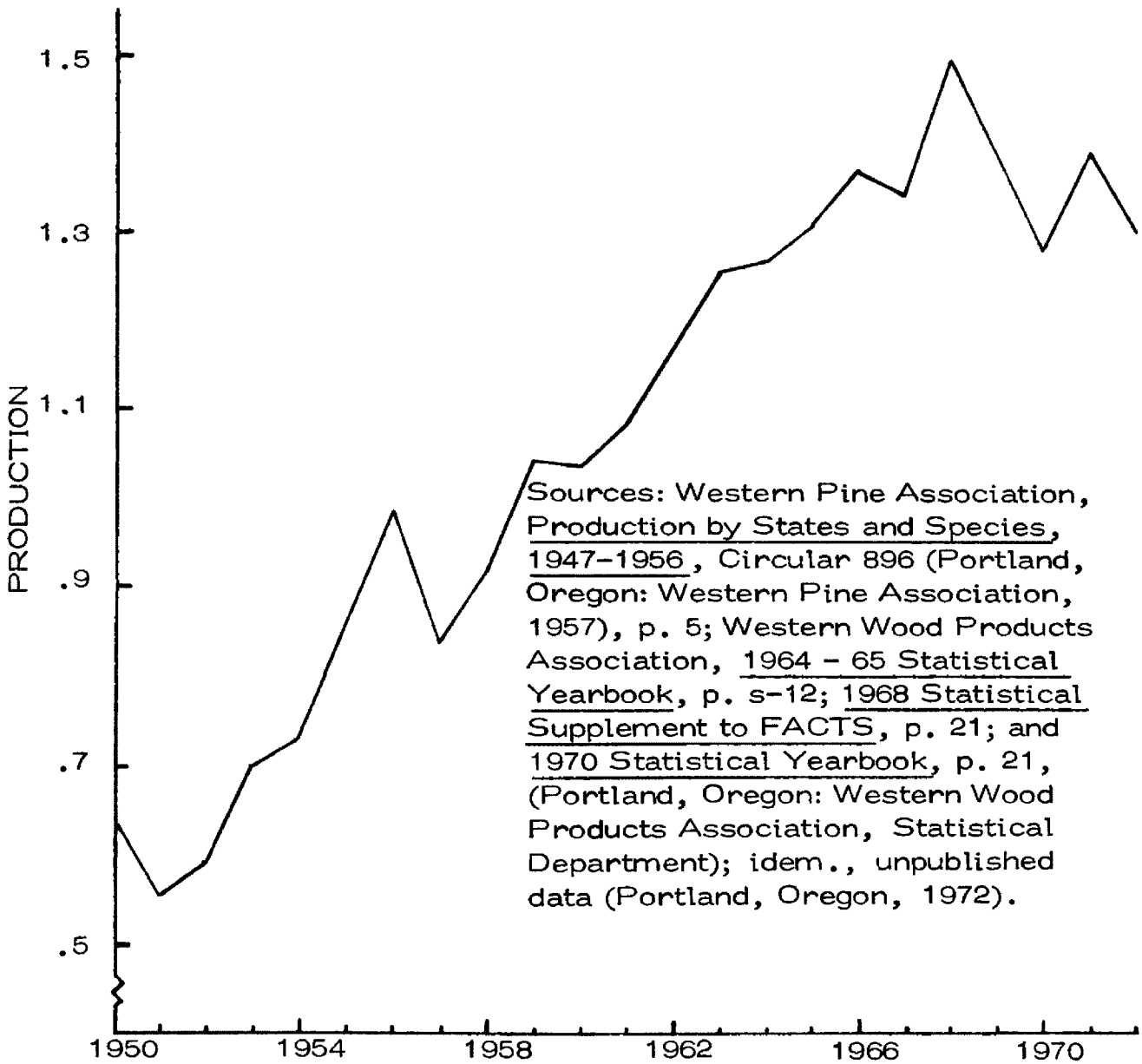

TABLE 17

NUMBER, PRODUCTION AND AVERAGE OUTPUT OF MONTANA SAWMILLS AND PLANING MILLS IN SELECTED YEARS

Year	Number	Production (mmbf)	Average Output (mmbf)
1947	190	640.0	3.4
1954	231	729.2	3.2
1956	333	979.1	2.9
1958	209	922.9	4.4
1963	175	1,166.0	6.7
1967	143	1,347.0	9.4
1969	139	1,397.0	10.0
1970	133	1,281.0	9.6

Sources: U.S. Department of Commerce, Bureau of the Census, Census of Manufacturers, 1947, 1954, 1958, 1963, 1967; and William F. DeLaney, "A Survey of the Western Montana Lumber Industry -- The Marketing Process Perspective", Master's Thesis, University of Montana, 1973), p. 10; and U. S. Department of Agriculture, Forest Service, Timber Products in the Rocky Mountain States, 1966, by Theodore S. Setzer and Alvin K. Wilson, Intermountain Forest and Range Experiment Station Resource Bulletin INT-9, (Ogden, Utah, 1970), p. 16; and Arnold W. Bolle, William K. Gibson and Elizabeth Hannum, The Forest Products Industry in Montana, (Missoula, Montana: Forest and Conservation Experiment Station, 1966), p. 18.

mills increased as lumber production grew to meet the burgeoning demand. The average size of all Montana mills decreased in the interval while total output increased. Many of these new mills must have been of small size. In 1957, excessive demand apparently satiated, the growth trend in sawmill numbers underwent a sharp reversal. Their numbers began a downward trek which is still continuing today. In one year (1957),the number of operating mills in Flathead County alone plummeted from 104 to 60.[1] By 1970 there were approximately 133 active sawmills in Montana, less than one-half the number operating in 1956. (Table 17).

Mills producing more than ten million board feet per year regained their dominance in 1956, producing 68 percent of Montana's lumber.[2] The growing dominance of larger mills[3] has been common in lumber production ever since. In 1966, 37 mills each producing in excess of 10 million board feet, manufactured 90 percent of all

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[1]Arnold W. Bolle, William K. Gibson and Elizabeth Hannum, The Forest Products Industry in Montana,(Missoula, Montana: Montana Forest and Conservation Experiment Station, 1966), p. 18.

[2]U.S. Department of Agriculture, Forest Service, The Forest Resource of Western Montana, by Henry Pissot and Harold E. Hanson, Intermountain Forest and Range Experiment Station Resource Bulletin INT-1 (Ogden, Utah, 1963), p. 13.

[3]Today mills producing 10 million board feet are commonly considered small. These mills were referred to as large in order to maintain continuity with earlier discussion of mill size.

the lumber in Montana.[1]

In 1970, the average mill size decreased slightly, but not as the result of small mills entering the industry as had been the case in the period from 1950 to 1956. In fact, on a net basis, new mills were not being established. In 1968 and during the first part of 1969, lumber prices increased sharply. Many mills increased their production by increasing the number of shifts operated and in the utilization of headrig capacity. Later in 1969 and in 1970 lumber prices fell. Mills found themselves in a market situation similar to 1967, when it was more profitable to operate at lower levels of output.

Location

Before any wood products plant can be built, there must be some assurance to the prospective owner that there is, above all, a suitable and available raw material supply. Only after this condition is met, will the owner decide if labor costs are favorable and whether a market for the proposed product can be reached profitably. It is not surprising, then, to find that most of the lumber manufactured in Montana is produced in the western part of the

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[1]U.S. Department of Agriculture, Forest Service, The Forest Resource of Western Montana, by Henry Pissot and Harold E. Hanson, Intermountain Forest and Range Experiment Station Resource Bulletin INT-1 (Ogden, Utah, 1963), p. 13.

state, where most of the commercial forest acreages and volumes are located. In fact six of the western counties have consistently provided about 80 percent of Montana's lumber production (Table 18). Three of these counties, Lincoln, Missoula and Flathead, produced between 50 and 60 percent of the state's lumber.

Ownership

In recent years, there has been a high turnover rate in the ownership of sawmill and planing mills. In 1973, Delaney found that nearly one-third of all current lumber firm ownerships had been acquired in the four years preceeding his study.[1] Of the 49 firms contacted in this study in the latter part of 1973, 12 had ceased operations since 1971. These 12 mills were small by today's standards, averaging an annual production of 12.4 million board feet in 1971 and, for the most part, were probably obsolete. However, their combined output totaled nearly 10 percent of the state's total production in 1971 which constitutes a substantial closure rate for a short two year period.

In 1970 it was estimated that corporations owned 88 percent of all the lumber firms in Montana and proprietors and partnerships another 6 percent each.[2] Lumber production by corporations

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[1]William F. Delaney, "A Survey of the Western Montana Lumber Industry--The Marketing Process Perspective", (Master's Thesis, University of Montana, 1973), p. 12.

[2]Ibid., p. 12.

TABLE 18

PERCENTAGES OF MONTANA'S LUMBER PRODUCTION PRODUCED BY SELECTED COUNTIES IN SELECTED YEARS

County	Year 1964	1966	1968	1970	1972
Flathead	14.3	16.3	15.9	16.6	15.4
Lake, Mineral and Sanders	19.5	18.7	18.0	19.3	22.7
Lincoln	22.3	22.4	22.5	21.9	21.7
Missoula	23.1	22.8	22.9	21.0	19.0
Total	79.2	80.2	79.3	78.8	78.8

Sources: Derived using Western Pine Association, xerox copy, "Lumber Production by County", Portland, Oregon: Western Wood Products Association, Statistical Department, 1974.

Note: Flathead County figures included Glacier County production which would result in a slight reduction in the figures ascribed to Flathead.

was probably a higher percentage than represented by their ownership, because corporations also own the largest firms. Corporate ownership is estimated to have been responsible for at least 90 percent and perhaps as much as 95 percent of Montana's total 1971 production.[1]

In recent years, integration of lumber firm ownership has proceeded at a rapid pace. Four corporations (Champion International, Louisiana Pacific, Hoerner Waldorf and Burlington Northern) have acquired mills since 1970 representing approximately 25 percent of the state's 1971 lumber production.[2] Three of these corporations have diversified interests in other sectors of Montana's wood products industry. The result of this integration is particularly manifested in the output of the four largest wood products corporations in Montana for various years. In 1969, these four largest firms accounted for 40 percent of Montana's lumber production, more than twice their percentage share one decade earlier.[3] By 1971, their production share

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[1]Estimate derived from interviews.

[2]Montana's 1971 production used here totaled 1,524 million board feet as derived from the estimates in the 1972 Directory of the Forest Products Industry. This production share would have been larger if the estimate of total production of 1,397 million board feet presented by the WWPA had been used.

[3]William F. Delaney, "A Survey of the Western Montana Lumber Industry--The Marketing Process Perspective," (Master's Thesis, University of Montana, 1973), p. 10.

increased to approximately 47 percent of the total lumber output in Montana.[1]

The Plywood Sector

Production

Prior to 1955 there was only one plywood mill in Montana which was located near Polson. The foundation for this mill was laid sometime around 1949 or 1950 when a mill at this site began producing high quality sliced western larch veneer.[2] This mill was later converted to plywood production (probably about 1952), and a rotary cutting process wherein a log is spun longitudinally against a knife to produce veneer, was added along with the necessary presses. By today's standards, this mill was small, with an annual production capacity of only 15 million square feet of three-eighths inch plywood (see Table 19 for production statistics).

Plywood production in Montana grew slowly until 1960. After 1960, new firms began producing plywood and total production increased dramatically. In 1966, six plants produced approximately 456 million square feet of three-eights inch plywood, 19 times the total production capacity of the industry 7 years earlier. Production

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[1]Derived from Directory of the Forest Products Industry, 1972 (Portland, Oregon: Miller Freeman Publications, 1972).

[2]Veneer is a sheet of wood of uniform thickness which is often glued together in three or more layers to form plywood.

since 1966 has apparently exceeded 400 million square feet, with production estimated at 447 million square feet for 1972.

Future plywood production (in the next decade) will exceed past production on the basis of a new plant built at Bonner by U.S. Plywood, a Division of Champion International. The construction of this plywood plant, one of the largest on the North American Continent, was completed in 1974. The plant has an annual production capacity exceeding 300 million square feet.[1]

Number of Plywood Plants and Average Production

The number of plywood plants in Montana and their average production is shown on Table 19. Prior to 1960, there was only one active plywood plant in Montana. Rapid development of this industry in Montana resulted in a total of four plants by 1962, and six plants by 1966. There has never been more than six active plywood plants at one time in Montana, and presently there are only five active plants. Two of the older plywood plants are no longer in operation.

The average production per firm has increased. In 1972, the average production per firm was more than double the 1962 average. Much of this increase resulted from the expansion of

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[1] "Production of Plywood Starts at New Plant", The Missoulian, March 3, 1974, p. 32.

TABLE 19

MONTANA PLYWOOD PRODUCTION AND THE NUMBER OF ACTIVE FIRMS AND THEIR AVERAGE PRODUCTION FOR SELECTED YEARS
(Production in Units of Million Square Feet of 3/8 Inch Plywood)

Year	Production	Number of Firms	Average Prod. Per Firm
1955[a]	15	1	15
1959[a]	24	1	24
1962	194	4	48.5
1964	363	5	72.6
1966	456	6	76.0
1968	414	5	82.8
1971	402	5	80.4
1972	447	4	111.8

Source: Directory of the Forest Products Industry; 1955, 1959, 1962, 1964, 1966, 1971, 1972 (Portland, Oregon: Miller Freeman Publications).

[a]These figures were those for the capacity of the single firm that was in operation. Therefore, these figures represent the maximum amount of production possible in these years.

existing facilities. Also, most of the new plants were larger than previously existing plants. As the plant at Bonner moves toward full production, average production per plant will increase substantially.

Location

All of the plywood mills that have been built in Montana have been located in the western part of the state. The four active plants in 1972 were concentrated in three counties: Missoula, Flathead and Lincoln. The plant in Missoula was the largest, producing 37 percent of all the plywood manufactured in 1972; the two plants in Flathead County combined for 45 percent and the plant in Libby contributed the remaining 18 percent.[1] With the new addition of U.S. Plywood's plant at Bonner, the majority of the plywood produced in Montana will shift from Flathead County to Missoula County. At present, all of the plywood production is located in the three counties which produce between 50 and 60 percent of Montana's lumber output.

Ownership

All of the plywood plants in Montana are owned by corporations. The owners of four of these plants, Burlington Northern, St. Regis, Champion International, and Evans are large

[1]Estimate derived from interviews and Table 19.

national corporations. All of the plywood firms in Montana are also affiliated with the ownership of one or more sawmills.

The Pulp and Paper Sector

The first pulpmill in Montana was established in Gallatin County in 1900. It was designed to produce paper from straw which was plentiful in that area, but was a financial failure and ceased operation after two years of production. A second attempt to manufacture paper was made at the same site using wood pulp shipped from Wisconsin. The attempt met with no better success than its predecessor. In 1905 the mill was dismantled and the machinery shipped out of the state.[1]

The only successful pulpmill to date was owned by the Waldorf Company, and began production near Missoula in 1956. The mill was designed originally to produce 250 tons of pulp per day from wood residues of sawmills in the Missoula vicinity. The pulp was baled and shipped to St. Paul for manufacture into paper. Later, the Waldorf Company formed a partnership with the Hoerner Company to produce kraft paper at the Missoula mill. The mill has undergone several expansions which boosted its daily pulp production capacity to 700 tons in 1965[2] and 1150 tons in

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[1] Arnold W. Bolle, "Forest Industries", Montana Almanac, Chapter 8, p. 219.

[2] Daniel T. Muldoon, "The Pulp and Paper Industry in the Northwest", (Master's Thesis, University of Montana, 1972).

1973.[1] The Hoerner Waldorf Corporation has proposed another expansion. The capacity of the mill will increase to 1850 tons of pulp per day.

The Particleboard Sector

Particleboard is the most recent member of the four major sectors of the woods product industry in Montana. The first particleboard plant in Montana was located in Missoula and began operations in 1970. The plant, owned by Evans Products Company, produced 14 million square feet of particleboard on a 3/4 inch basis in 1970 and 76 million square feet in 1971.[2] The plant is capable of utilizing 450 tons of planer shavings and sawdust per day to produce particleboard. The annual capacity of the mill is 108 million square feet of particleboard on a 3/4 inch basis.[3]

A new particleboard (medium density fiberboard) plant has just begun operations in Flathead County near Columbia Falls. The plant, owned by Plum Creek Lumber Company (Burlington Northern) has the annual capacity to utilize 110 thousand oven-dry

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[1] Lloyd Berg, et. al., Summary of the Environmental Impact Statement on the Proposed Expansion of Hoerner Waldorf's Missoula Pulp and Paper Mill, (Missoula, Montana: Hoerner Waldorf Corporation, n.d.), pp. 5,8,9.

[2] Directory of the Forest Products Industry, 1972 and 1973, (Portland, Oregon: Miller Freeman Publications, 1972), p. 459.

[3] Ibid., 1972, p. 459.

tons of planer shavings and sawdust. The plant will produce medium density fiberboard and is expected to be in full operation in April of 1975.

Summary

The wood products industry in Montana has expanded in size and diversified in product lines immensely since 1950. Lumber production in 1972 was more than twice the 1950 output. The plywood, pulp and paper and particleboard sectors are all relatively recent additions to the industry. Even with this diversification, however, the welfare of the industry is still inseparably linked to the health of the lumber sector. Not only is the lumber sector responsible for the demand for the vast majority of logs, 86 percent of the total in 1969,[1] but the lumber sector's residues are also the basis for the existence of the pulp and paper and particleboard operations in Montana. Pulp and paper operations would probably suffer the most economically as a result of a substantial reduction in lumber production. Pulp and paper markets are not tied to the same market as for lumber and particleboard. The lumber and particleboard sectors supply the same markets. Market conditions that dictate a reduction in

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[1]U.S. Department of Agriculture, Forest Service, Estimates of Timber Products Output and Plant Residues, Montana, 1969, by Theodore Setzer, Intermountain Forest and Range Experiment Station Research Note INT-133 (Ogden, Utah, 1971), pp. 1-4.

output for one sector nearly equally apply to the other.

Wood products output in Montana is heavily concentrated in western Montana, especially in Flathead, Missoula and Lincoln Counties. These three counties produce over 50 percent of Montana's total lumber output, and 100 percent of the state's pulp and paper, particleboard, and plywood outputs.

Business firms organized as corporations own nearly all of the production capacity of the wood products industry in Montana. The movement toward the corporate form of ownership was important in the past because of the ease of raising greater amounts of capital than most proprietorships and partnerships could raise. Additional capital resources generally enhance the ability of mills to survive the normal severe economic conditions of the wood products industry.

The movement toward the larger output of mills in all sectors may be important in terms of future ownership and in the stability of mill operations. Increased production per mill generally requires larger amounts of capital investment which can best be obtained by larger corporations. To the extent that larger amounts of capital are invested in labor-saving devices, fixed costs are increased and average variable costs are decreased. These mills will be able to cover average variable costs and remain in operation in short run time periods when demand and supply

situations dictate a product price which is insufficient to cover the higher average variable costs of many other mills.[1]

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[1]Short run time periods are an economic concept of production periods when mill capacity is fixed.

CHAPTER 5

ACTUAL AND PROBABLE TECHNOLOGICAL CHANGE IN MONTANA'S WOOD PRODUCTS INDUSTRY AND ITS IMPACT ON EMPLOYMENT

Information documenting past technological changes in Montana's wood products industry and the impact of those changes upon employment is scarce. Because of this lack of knowledge, we will look at indications of technological changes and their associated impacts rather than looking directly at actual changes. Discussion of labor efficiency and capital expenditures in the wood products industry of Montana will hopefully indicate the magnitude and importance of technological change in this industry. Information gathered in the discussion of these indicators will be fortified with data gathered in interviews and then used as a basis for projecting future employment levels and the role of technology in those levels for the various sectors of this industry.

Indications of Past Technological Change

Labor Efficiency

Change in labor efficiency is not only indicative of the magnitude of technological change, but also it is a direct economic result of that change. Basically, the efficiency of labor reflects

either changes in the type of technology used or in the use of existing technology. If the ratio of labor to volume produced remains relatively constant over a period of time, any technological change which occurred during the period had only minimal impact on employment. If, however, significantly fewer men are required to produce a given volume of product over a period of time, a change in the use of technology in the industry may be presumed. The indication of changes which created an impact upon employment is of primary importance, because it is the trends in these changes which produces a preview of what might be expected in the future.

The Lumber Sector

The lumber sector is the only one of the four wood products sectors discussed in this paper which is well suited for diagnosis of technological innovation via changes in labor productivity. Labor productivity statistics for the other sectors in Montana are not available. The suggestion that there may have been recent significant technological change in this sector, whose roots in Montana extend back well over a century ago, may come as a surprise to some people. With that much time, it would be quite natural to expect the lumber sector to have nearly perfected its manufacturing technique.

Table 20 shows employment, production and output per man year for the lumber sector in the period from 1950 to 1972. In

TABLE 20

EMPLOYMENT, PRODUCTION AND OUTPUT PER MAN YEAR IN THE LUMBER SECTOR FOR THE PERIOD 1950-1972

Year	Employment[a]	Production (mmbm)	Output/Man/ Year (mbm)
1950	3,898	640.0	164.2
1951	4,333	552.1	127.4
1952	4,207	593.5	141.1
1953	4,369	700.0	160.2
1954	4,420	729.2	165.0
1955	4,991	867.4	173.8
1956	5,242	969.1	186.8
1957	4,587	839.9	183.1
1958	4,654	922.9	198.3
1959	5,128	1,043.0	203.4
1960	4,880	1,035.0	212.1
1961	4,776	1,083.0	225.8
1962	5,362	1,259.0	217.5
1963	5,583	1,166.0	208.8
1964	5,307	1,271.0	239.5
1965	5,315	1,311.0	246.7
1966	5,389	1,375.0	255.1
1967	5,531	1,347.0	243.5
1968	5,757	1,499.0	260.4
1969	5,661	1,397.0	246.8
1970	5,229	1,281.0	245.0
1971	5,578	1,397.0	250.4
1972	5,972	1,311.0	219.5

[a]includes all wage and salary workers in the sector

Source: Johnson, "Wood Products in Montana", Montana Business Quarterly 10 (Spring, 1974), p. 25; Arnold W. Bolle, William K. Gibson and Elizabeth Hannum, The Forest Products Industry in Montana, (Missoula, Montana: Montana Forest and Conservation Experiment Station, 1966), p. 42; Western Wood Products Association, 1970 Statistical Yearbook, (Portland, Oregon: Western Wood Products Association Statistical Department, 1971), p. 19.

1972 Montana produced 1,311 million board feet of lumber, 105 percent more than in 1950. Employment of wage and salary workers in the lumber sector in 1972 totaled 5,972, an increase of 53 percent since 1950. Because production increased significantly more than employment, it is readily apparent that the labor force in 1972 was much more productive than in 1950. Labor productivity, in terms of thousands of board feet of lumber produced per man year of labor, increased from 164.1 in 1950 to 219.5 in 1972. Translated into terms of percentage change in productivity, this gain in labor efficiency means that on the average, each wage and salary worker in the sawmill and planing mills of Montana produced 34 percent more lumber in 1972 than did his 1950 counterpart. Because of the magnitude of these gains, we may assume that there probably was significant technological change in the industry between 1950 and 1972.

Future gains in labor productivity in the lumber sector similar to those realized in the period between 1950 and 1972 will have a profound effect on employment in this sector. Future timber harvests will support substantially less employment in the saw mills and planing mills in Montana unless the volume of timber harvested increases at a faster rate than labor productivity. A rapidly expanding lumber output between 1950 and 1972 (105 percent) is all that kept employment in this sector from declining during that

period. Changes in the volume of timber offered for sale from Forest Service lands, as indicated in Chapter 4, may provide future increases in timber harvest and hence an increase in lumber output. Future improvement in the utilization of timber will also add substantially to the total timber supply and should not be overlooked.

The magnitude of these productivity gains cannot be ascribed entirely to technological changes; other factors were present which also affect productivity. These factors, which may be either pro or con in their impact on labor efficiency, include changing log sizes, degree of manufacture, product mixes, lumber sizes and employment psychology. These factors are discussed briefly to promote a better understanding of how they affect labor productivity.

One factor which appears to have a negative influence on productivity gains is the move toward the manufacture of lumber and plywood from smaller logs. More time is often required per unit of product produced to handle smaller logs. The increasing volume of smaller logs mixed with larger logs often necessitates additional labor to sort the logs prior to manufacturing. On the basis of size, logs are often diverted to different types of saws specializing in large or small logs in an effort to optimize the value of the products manufactured and enhance labor efficiency

prospects. Decreasing log size also tends to increase handling costs because more small logs are required to produce the same volume of lumber or plywood obtained from fewer, but larger logs. Nearly all of the mill managers interviewed in the study asserted that the average size of logs utilized in their mill had diminished considerably in the past ten years, however, only two of them knew the actual dimensions of the size reduction. The possibility that these two mills were representative of the situation throughout Montana is so remote that these two observations are not cited in this presentation. Because of the lack of records of the changes in log size, it is not possible to ascertain the extent to which these changes may have influenced productivity.

The degree of manufacture also affects productivity and it is not a static factor. More manpower is required to produce one unit of planed lumber than one unit of rough lumber and more to produce one unit of dried lumber than one unit of green lumber. The volume of lumber sold on a dry basis in Montana, for example, accounted for 82.2 percent of the total lumber produced in 1968 and 92.5 percent in 1972.[1] The difference in the amount of processing between these two years may be indicative of a general movement

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[1]Western Wood Products Association, 1970 Statistical Yearbook, (Portland, Oregon: Western Wood Products Association Statistical Department, 1968, 1972), p. 5.

toward a finer degree of lumber manufacture for the whole industry. Volumes of lumber sold on a dry basis as cited by Delaney[1] for the years 1963 and 1969, accounted for 80 and 85 percent of the totals respectively which tends to substantiate the suggestion of a general movement toward a finer degree of lumber processing. No attempt was made in the study to relate the magnitude of the impact of changes in the degree of lumber processing to changes in labor productivity. The installation of additional dryer or planer capacity in the lumber sector may reduce apparent productivity because of an increase in the size of the total production process. This case is worth mentioning because an increase in the sophistication of product manufacture may lead to a decrease in labor efficiency.

Product mix has been an important variable in changing labor productivities. The term lumber applies to a mix of products which vary in thickness from less than two inches to over five inches, and from one inch to over five inches in width. The larger the dimensions of the lumber, the larger the volume produced in a single pass through a saw and hence the greater productivity. The volumes of lumber produced in different sizes varies from year to

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[1]William F. Delaney, "A Survey of the Western Montana Lumber Industry--The Marketing Process Perspective",(Master's Thesis, University of Montana, 1973), p. 17.

year, let alone over the twenty-five year period under consideration. No consistent records of these variations have been kept and so it is not possible to estimate the impact of changing product mixes on productivity. However, we do know that the market share held by dimension lumber (nominally two to five inches thick and varying in width) has increased at the expense of boards (one inch thick and varying in width). In 1950, plywood was not wholly accepted in Montana building markets and much of the walls, floors and roofs of residential housing were sheathed with boards. Now plywood dominates the sheathing market with some help from particleboard in sub-flooring. As a result of this change in product use, Montana sawmills now predominantly produce dimension lumber, most of which are studs. Nine mills interviewed in the study produced 439.1 million board feet in 1972, of which 321.4 million board feet or 73 percent was dimension lumber. This increase in the proportion of dimension lumber produced relative to boards led to an increase in productivity, but we simply don't know the magnitude of that increase.

Product mix also influences labor productivity in the plywood, particleboard and pulp and paper sectors. The different dimensions of products produced within these sectors result in different productivities. Product mix is an important variable in any discussion of the impact of technological change on employment

via labor productivity.

The standard sizes of lumber have been reduced since 1950, though the apparent or nominal sizes have remained constant. For example, a 2 x 4 stud is actually smaller than two inches thick and four inches wide, but now it is even smaller. Productivity is enhanced by reductions in actual lumber sizes because more lumber can be cut from fewer logs which in turn reduces the necessary manpower input. Unfortunately, from a standpoint of separating out major factors which have an impact on labor productivity, the magnitude of the impact of dimension changes in standard lumber sizes upon productivity has not been documented.

Another factor which may have contributed in some way to the declines in the productivity of production workers (suggested by some mill owners) may be a tendency to over-react to changes in markets. In times of good lumber markets, there is a tendency to employ more labor than necessary to efficiently accomplish the job. In poor market periods, there seems to be a tendency to give the belt a resounding yank, leaving the remaining workers gasping for help which is answered incrementally by slowly adjusting employment upwards. The extent to which these reactions occur would vary tremendously between different mill ownerships and would be difficult to anticipate numerically in employment forecasts. This tendency may diminish somewhat as large corporations with better

management techniques available to them continue to increase their share of the total output. The presence of these factors, whose impact upon labor efficiency in the wood products industry is not quantifiable at this time, complicates the seclusion of the single impact of technology upon productivity and hence upon employment. Changes in labor productivity may, however, still be interpreted as an indicator of possible technological change.

New Capital Expenditures

Capital expended to replace or expand existing capital assets, new capital expenditures, may also be used an an indicator of technological change. The replacement or expansion of capital assets generally indicates a distinct possibility of an improvement in technology which may have influenced labor efficiency. Table 21 shows, for the period 1959 through 1971, the new capital expenditures made in the industry exclusive of the pulp and paper mill. The sawmill and planing mill sector is the only sector for which there is some continuity of data in capital expenditures. Data for the particleboard and plywood sectors is recorded only from 1963 through 1967. The fact that the data for these two sectors is given under mill work and related products, which among other things includes cut stock plants generally related with sawmill operations, further compounds problems. Because of these problems, the sawmill and planing mill sector is the only sector which has sufficient

TABLE 21

NEW CAPITAL EXPENDITURES IN MONTANA'S WOOD PRODUCTS INDUSTRY
(Millions of Dollars)

Year	Lumber & Wood Products	Sawmills & Planing Mills	Millwork & Related	Percent of Total	
				Sawmills	Millwork & Related
1959	NA	3.1	NA	NA	NA
1960	NA	3.2	NA	NA	NA
1961	NA	3.5	NA	NA	NA
1962	13.6	10.7	NA	78	NA
1963	9.8	6.0	.8	61	8
1964	11.1	5.6	1.6	50	14
1965	8.9	4.9	2.7	55	30
1966	8.6	2.7	4.3	31	50
1967	6.2	3.2	1.4	52	23
1968	9.9	NA	NA	NA	NA
1969	9.6	3.4	NA	35	NA
1970	12.1	4.9	NA	40	NA
1971	13.6	4.7	NA	35	NA

Note: This table excludes the pulp and paper sector. NA means not available.

Source: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufacturers, 1959-1971.

data to justify further analysis relative to technological innovation and changes in labor efficiency.

New capital expenditures in the sawmill and planing mill sector averaged approximately $4.7 million dollars per year for the period 1959 to 1971. In 1962, an expenditure of $10.7 million dollars was recorded; of this sum, approximately $4.5 million dollars was spent on the expansion and overhaul of one sawmill and planing mill near Missoula, Montana.[1] If one sawmill can digest this large sum of money, the average of $4.7 million dollars each year would not necessarily connote the appeasement of the appetite for renovation of many sawmills throughout the state. However, the production capabilities of this one mill is equal to approximately 10 percent of the state's total. Therefore, the extent of these expenditures suggest substantial technological change in this sector.

Figure 8 shows the impact of possible technological changes as indicated by capital expenditures on the efficiency of production workers in the sawmill and planing mill sector. Throughout the period, 1959 to 1972, the efficiency of production workers did not respond to the technological changes indicated by capital

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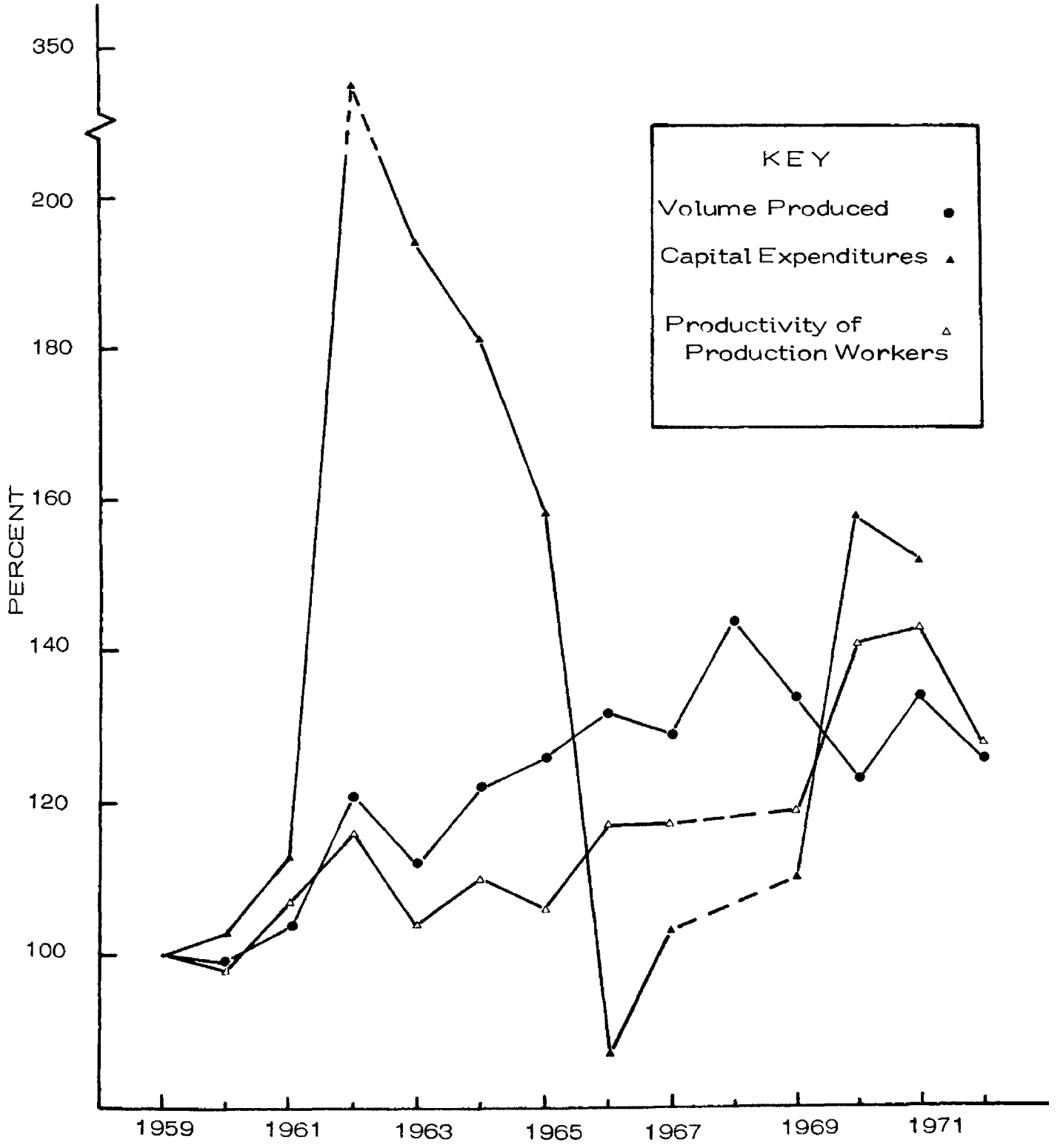
[1]Clarence W. Nelson, The Timber Economy of the Ninth District West, (Minneapolis, Minnesota: Federal Reserve Bank of Minneapolis, 1963), p. 41.

Figure 8. Capital investment, production and the productivity of production workers in the lumber sector expressed as a percentage of their 1959 levels (1959 - 1972).



expenditures. Apparently, the majority of capital assets replaced or expanded were incapable of creating major improvements in labor efficiency. These capital expenditures may have been necessary to offset the negative influence of other factors affecting productivity such as decreasing log size.

There are several other reasons which may explain the lack of relationship between capital expenditures and productivity. There may be a lag time between investment and impact on productivity gains. Probably most important of all is the fact that this expenditure category does not differentiate between investments in productivity and non-productivity oriented endeavors. Many mills have invested large sums of money in new log debarkers and residue chippers with the prime objective being to increase utilization not efficiency.

An alternative method of viewing the impact of new capital expenditures upon labor efficiency in Montana's wood products industry was developed in a study by Richard Porterfield.[1] This method utilized the net value added per employee hour of labor as an indicator of labor efficiency. This study found that in 1972, the net value added per employee hour of labor was higher in Montana than the average for the United States for both the lumber

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[1]Richard L. Porterfield, "A Profile of Forestry Employment in Montana", Missoula, 1974 (mimeograph of rough draft), pp. 29, 30, 32.

and wood products industry as a whole ($5.98 vs. $5.43) and for the sawmill and planing mill sector ($6.03 vs. $5.46). This relative standing for the industry represents an increase from 1967 when Montana ranked lower than the average for the country. In relating productivity measured by net value added per employee hour of labor to new capital expenditures, Porterfield was able to discern only a weak relationship at best between these two variables. Lag time between capital expenditures and changes in efficiency and decreasing log sizes were offered as possible explanations for the lack of direct relationship between capital expenditures were not found to reflect increased labor productivity.

The discussion of labor productivity and capital expenditures failed to yield information that would permit crediting or discrediting of technological change as a principal agent in labor efficiency gains. Changes in technology still loom as possible explanations of major changes in the employment requirements of the sawmill and planing mill sector. Interviews with mill managers, discussed in a later section, were conducted in hopes of defining the actual role of technology in these changes.

Productivity Trends

In developing productivity trends, a distinction should be made between production workers and non-production workers. The reaction of these two groups of workers to different factors is

often not the same. The isolation of each group's productivity reaction to a given variable factor allows a more precise indication of possible future trends in labor efficiency and hence employment at different production levels. Tables 22 and 23 and Figure 9 provide the basic information necessary for this discussion. Table 22 expresses productivity estimates for production workers in the sawmill and planing mill sector. Productivity is expressed in terms of the volume of lumber produced per employee hour of labor for most years in the period extending from 1959 through 1972. Productivity data for 1968 and for the years preceeding 1959 were not included because no source was found which referred to the total number of production worker man-hours utilized in this sector for those years. To expedite comparison, changes in productivity since 1959 for both the production and the non-production workers are shown simultaneously in Table 23 and Figure 9. Quantities are expressed as a percentage of the 1959 levels represented by their respective totals in the various years. The output of production workers in the lumber sector increased from 115 board feet per hour in 1959 to 147 board feet per hour in 1972, an increase of 28 percent for the period. During this same period the combination of production and non-production workers increased their efficiency only 8 percent in this period. Because the gains made by the production workers were so much larger than

TABLE 22

HOURS WORKED BY PRODUCTION WORKERS, VOLUME PRODUCED AND PRODUCTIVITY IN THE LUMBER SECTOR
1959 to 1972

Year	Hours Worked By Production Workers	Volume Produced (mmbf)	Production Per Man Hour (bf)
1959	9,066,000	1,043	115
1960	9,182,000	1,035	113
1961	8,793,000	1,083	123
1962	9,433,000	1,259	133
1963	9,702,000	1,155	120
1964	9,971,000	1,271	127
1965	10,726,000	1,311	122
1966	10,263,000	1,375	134
1967	10,000,000	1,347	135
1968	--[a]	1,499	--[a]
1969	10,200,000	1,397	137
1970	7,900,000	1,281	162
1971	8,500,000	1,397	164
1972	8,900,000	1,311	147

[a]data not available

Source: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufacturers, 1959-1971; Table 20.

TABLE 23

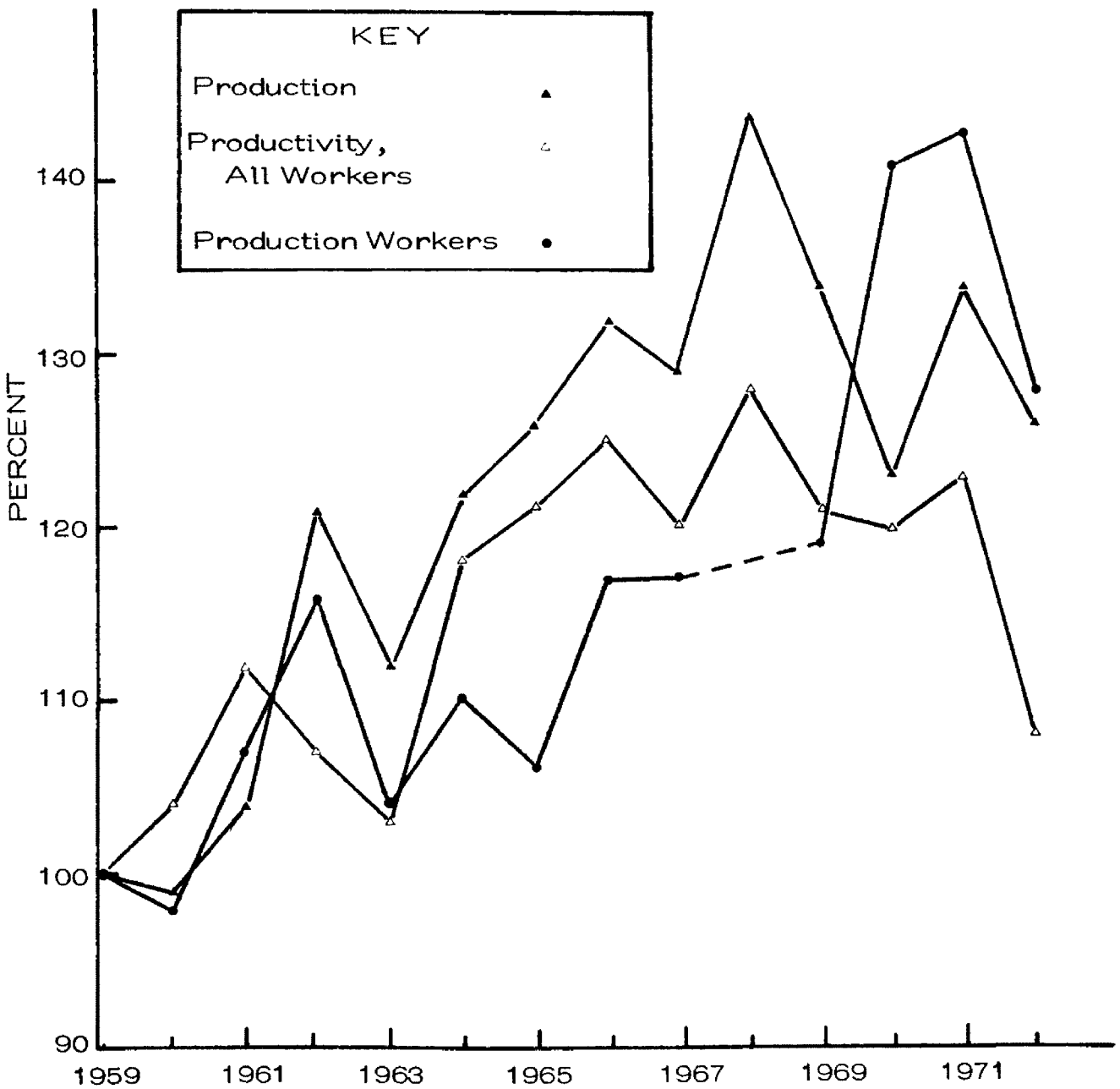
PERCENTAGE CHANGE IN VOLUME PRODUCED AND PRODUCTIVITY IN THE LUMBER SECTOR, 1959 to 1972
(Base Year, 1959 = 100%)

Year	Volume Produced	Productivity	
		All Wage and Salary Workers	Production Workers Only
1959	100	100	100
1960	99	104	98
1961	104	112	107
1962	121	107	116
1963	112	193	104
1964	122	118	110
1965	126	121	106
1966	132	125	117
1967	129	120	117
1968	144	128	--[a]
1969	134	121	119
1970	123	120	141
1971	134	123	143
1972	126	108	128

[a]data not available

Source: Derived from Tables 20 and 22.

Figure 9. Percentage change in volume produced and productivity in the lumber sector, 1959 - 1972. Base year, 1959 = 100 percent.



those achieved by the group composed of all workers it is evident that the productivity of non-production workers must have progressed, if at all, at a rate much less than 8 percent. The movement in the efficiency of all wage and salary workers in this sector closely coincided with similar movements in lumber output (refer to Figure 9). A given quantity of non-production workers, including managers, secretaries and bookkeepers are required over a fairly broad range of production levels. When production is increased, few non-production workers need be hired and so the productivity of these workers necessarily increases. When production is decreased, few of the non-production workers can be laid off, consequently reducing the productivity of these workers. Also, the skill and education level of many of the non-production workers is generally higher than that of most production workers. Competent replacements for these skilled non-production workers are not always located easily, consequently the services of these workers are coveted to the extent that they are not readily relinquished.

Movements in the labor efficiency of production workers was less predictable than for non-production workers. The efficiency of these workers visited many peaks and valleys in the course of the 28 percent progression realized during the period from 1959 through 1972. Once a productivity gain was achieved,

that gain was susceptible not only to further increases but also to decreases. The decreases in labor efficiency in this group are especially difficult to rationalize. One would think that once a higher level of efficiency among production workers was attained, that it would be sustained. Production workers in the wood products industry in Montana, as a group, are not educated as highly as employees of many other major industries.[1] Generally, the lower the educational level of the worker, the more expendable are the services of that worker during times of financial stress. When lumber production is reduced due to unfavorable market conditions, one would normally expect that these more expendable workers would readily be released in an effort to maintain a favorable manpower efficiency ratio. The number of production workers in Montana actually was reduced in times of receding lumber markets, especially in 1969 and 1972 as shown in Figure 10. Montana sawmills, however, could not or did not lay off enough production workers to maintain higher productivity levels. During the production worker productivity recessions of 1962-1963 and 1971-1972, employment was actually increasing while production was decreasing.

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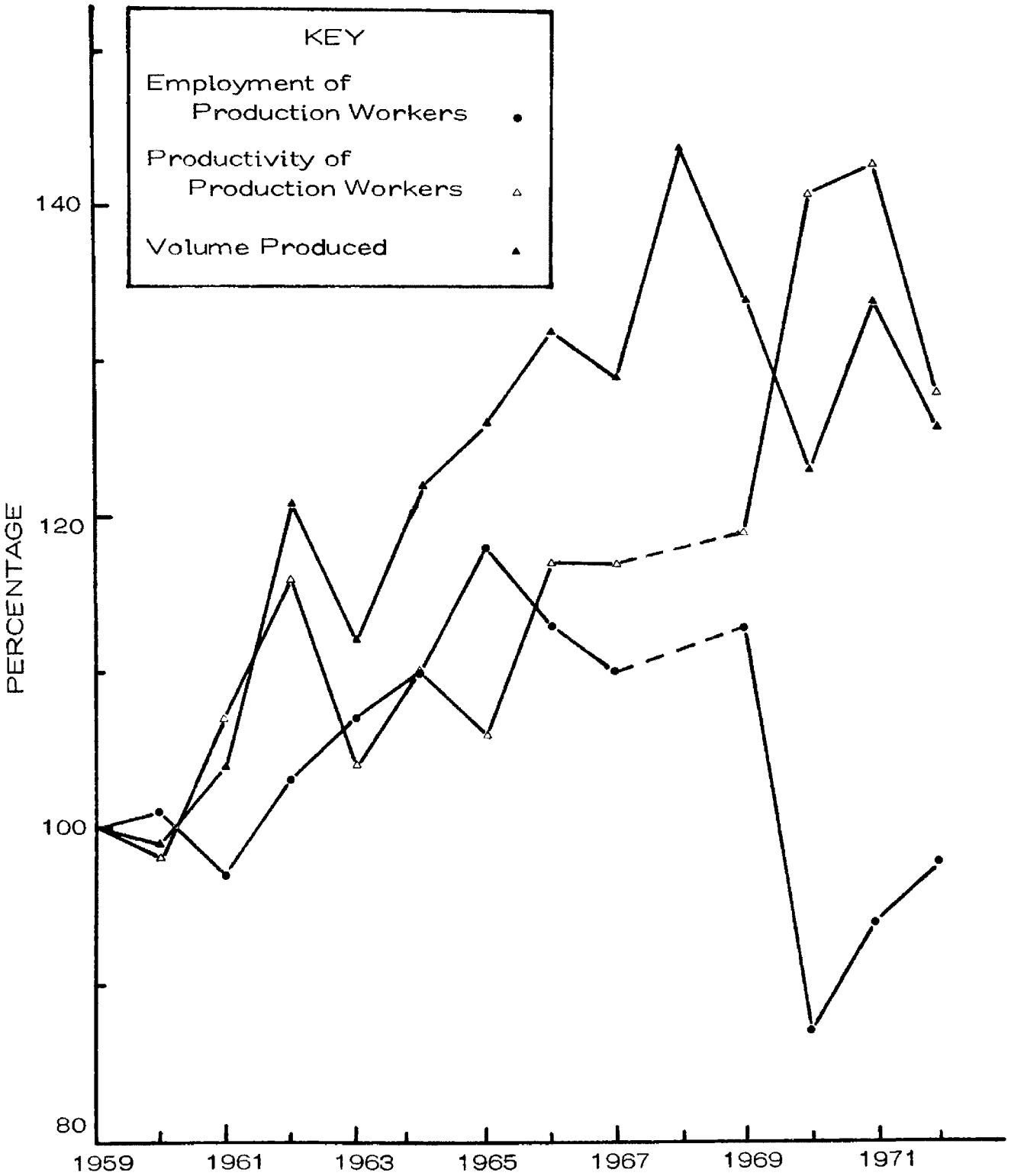
[1]Richard L. Porterfield, "A Profile of Forestry Employment in Montana"; Missoula, 1974 (mimeograph of rough draft), p. 1.

Figure 10. Percentage change in volume produced and production worker productivity and employment in the lumber sector, 1969 - 1972. Base year, 1969 = 100 percent.



Source: Tables 22 and 23

Thus far, information about technological change and productivity has accumulated but not put to use in predicting future employment in the sawmill and planing mill sector because we have not been able to determine the nature of the relationship between the two variables. This problem was anticipated to some extent and several interview questions focused on clarifying this relationship. Hopefully, the discussion of the answers to those questions will more clearly identify the connection between technology and productivity.

Interviews

All of the mill owners and managers interviewed were asked to indicate investments larger than $10,000 made in their mills since 1960. Many mills had just recently assumed their present ownership and records of changes made in times of other ownerships simply did not exist. The amount of bookwork necessary to fulfill the basic requirements of this question precluded still others from answering even part of the question. Despite these problems, twelve mills which combined for an estimated production of 594 million board feet in 1972 did respond to the question. There is some problem with the interpretation of the answers received because of the variation in time spans mill managers were able to consider in framing their answers. Some of the pressure created by this problem was relieved by

considering only investments made since 1968 because all of these mills went back that far in time to answer the question if they were under the same ownership that long.

Interview data will be used to relate the technology and expenditures in these mills to the efficiency levels they achieved in 1972. Unfortunately, the impact of these specific technological changes upon labor efficiency cannot be estimated because efficiency information prior to these changes was not obtained in the interviews. Employment and mill production data was requested for the years 1960, 1965, 1969 and 1972 but a predominant number of mills had the appropriate information for only 1972. The efficiency levels in these mills will be compared with the averages for the whole sector in that year to see if the type of technology installed in these mills created a significantly different employment situation than elsewhere in Montana.

These twelve mills, which represent the ownership of approximately 39 percent of Montana's 1972 total lumber production, listed investments in their mills of $5.9 million dollars since 1968. Of this total, $3.3 million, or 56 percent, was spent on equipment which was designed to handle smaller logs and to produce studs as a primary product. New log debarking devices and saws such as beavers, quadband saws and twin band saws constituted the majority of these expenditures. Equipment designed to reduce wood residues

into chips for the pulpmill and bark into material suitable for burning in boilers accounted for an additional .4 million dollars. Investments, such as these in new chippers and boilers--typically non-productive type equipment, help explain the absence of a cause and effect relationship between new capital expenditures and productivity.

The average productivity of all wage and salary workers in the twelve mills in 1972 was calculated and found to equal 355 thousand board feet per man per year. This total is slightly more than 50 percent greater than the 219.5 thousand board feet average indicated in Table 20 for the whole sector. In terms of productivity, the twelve mills which invested over one-half of their new expenditures in small log equipment were richly rewarded. The success of these mills leaves other mills characterized by lower productivity levels suspect to the lack of investment in, or the non-use of more efficient technology. Sawmills and planing mills are clearly not achieving productivity levels within the capabilities of present technology.

These mills did not invest in small log equipment to the exclusion of large log equipment. All of the mills had one or more saws specifically designed to saw large logs, and two mills had only large log saws. The ownership of more than one saw type specializing in different log sizes would logically be a positive

agent in labor efficiency levels, especially considering that the log input often ranges in diameter from over three feet to less than six inches.

Information gathered in interviews also allows a pinhole view of future types of technological changes in Montana's lumber sector. The observations from the interviews are included here to show how the managers of some Montana mills view the future with respect to the appropriate technology in their mills. Most managers were uncertain of the effect these changes would have on employment in their mills, and so such figures cannot be cited.

Seven mills, accounting for a total production of 388.7 million board feet in 1972, answered the interview question relating to planned future investment. These mills were among the twelve mills noted earlier for their excellent efficiency. The management of these mills planned investments totaling $4.3 million dollars, all of which was to be expended within the next five years and most of which was currently being installed. The acquisition of log debarkers and saws accounted for $3.7 million dollars or 86 percent of the total investments. Generally, the implementation of this equipment was to serve a three-fold purpose: 1) the replacement of depreciated equipment, 2) the increase in utilization of wood fiber by reducing waste in the manufacture of primary products and

or the more efficient recovery of mill residue and 3) to increase labor efficiency. Two of the seven mills planned no capital investments larger than $10,000 within the next five years.

As of the fourth quarter of 1974, many of the larger mills producing in excess of thirty million board feet per year have ceased operations. Nearly all of the major sawmills have reduced their lumber production and have reduced the number of workers in their operations. The primary cause of the reduced output and worker layoffs is a dramatic reduction in the residential housing construction market and no immediate end of this situation is in sight. Investments underway in these mills at the time of the interview and prior to the depression in lumber markets are now largely complete. Most mills which had not begun their investments prior to the market slump are waiting to go ahead with their plans until the appearance of the lumber market improves.

Projection of Employment Changes Created By Specific Future Technological Changes

Three different frameworks have been constructed in this chapter which suggest the possibility of substantial impact of technology on employment levels in Montana's wood products industry. These same frameworks, (indications of technological change, productivity trends and specific technological changes), also provide a basis for projecting future levels of employment in

the industry. The basic assumption that circumstantial factors contributing to these relationships will exist in the future, and that their future occurrence will occasion influences in productivity levels similar to the past, facilitates the use of these frameworks in projections of future productivity levels.

Projections Using Indications of Past Technological Impact on Employment as a Guide

Our examination of both labor productivity and capital expenditures both indicated the possibility of substantial technological change in the sawmill and planing mill sector of the wood products industry. Each wage and salary worker in this sector in 1972 produced 34 percent more than did his 1950 counterpart. Capital expenditures in this sector averaged approximately $4.7 million dollars per year for the period 1959 to 1971. The level of expenditure was capable of expanding and overhauling an estimated 10 percent of the total sawmill and planing mill capacity in 1962.[1]

The relationship between these indicators and a change in technology resulting in increased labor productivity, however, remains nebulous because of extenuating circumstances. These circumstances refer to the fact that several other factors discussed

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[1]This follows from the earlier discussion of one mill producing approximately 10 percent of all the lumber manufactured in Montana, which was modernized and renovated for $4.5 million dollars in 1962.

in this chapter in addition to technological change may result in productivity changes. These factors could not be segregated from technology in the study and so the impact of technology alone on productivity cannot be estimated. Only a poor relationship was found to exist between capital expenditures and labor productivity which was measured in terms of physical output per employee and in terms of value added per employee hour of labor. Because of the lack of a clear relationship between these indicators and labor productivity, it is not possible to accurately predict future levels of employment resulting from technological changes alone. The following projections of productivity levels derived from past trends in labor productivity, then, will not only reflect the extension of the impact of technological changes, but also the extension of other factors which also influenced past changes in labor productivity.

Projection of Productivity Trends

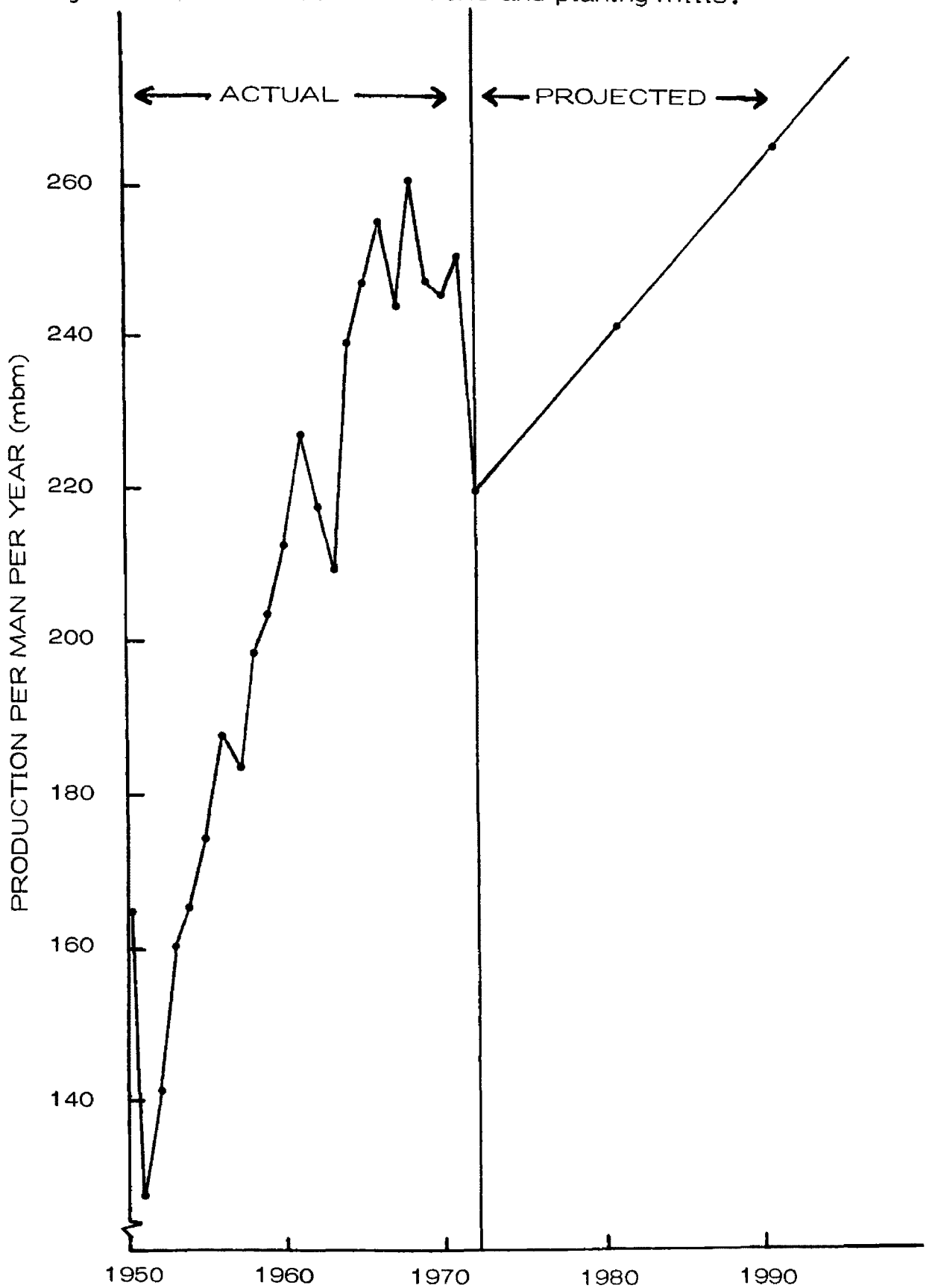
As a function of average past technological change there are many techniques which may be used to project into the future data collected in the past. Only one of these techniques is presented in this discussion, and it is meant to be used only as an academic exercise to expose the futility of projecting future productivity levels based on past occurrences. The method used here will project (into the future) past productivity levels as a function of

the average rates of change that have occurred in the past. We are again limited to the sawmill and planing mill sector, the only sector in Montana's wood products industry for which there is reasonably reliable data. Data is available and has been presented in this paper for all wage and salary workers in the sector since 1960 (Table 20).

Productivity of all workers in the sector ranged from 164.2 thousand board feet in 1950 to 219.5 thousand board feet in 1972. The total change in productivity during this period obtained by subtracting 164.2 from 219.5 is equal to 55.3 board feet per man. The average gain in productivity per man per year of labor is obtained by dividing 55.3 by the twenty-three years in the period and is equal to an increase of 2.4 board feet in each successive year. Estimates of future productivity are derived by projecting gains of 2.4 board feet per man year of labor for each successive year into the future. Projections calculated in this manner are shown in Figure 11.

These estimations are poor indicators of productivity levels which may logically be expected to occur at any one instance in the future because of the magnitude of past variations. Fluctuations in past productivity levels were nearly 20 times as large as the 2.4 board feet per man per year predicted in these projections. In a time span of one year, past levels have decreased as much as

Figure 11. Actual and projected productivity for all wage and salary workers in Montana sawmills and planing mills.



37 board feet and increased as much as 19 board feet. Also, productivity levels achieved in 1968 are equal in magnitude to those levels projected to occur in 1990.

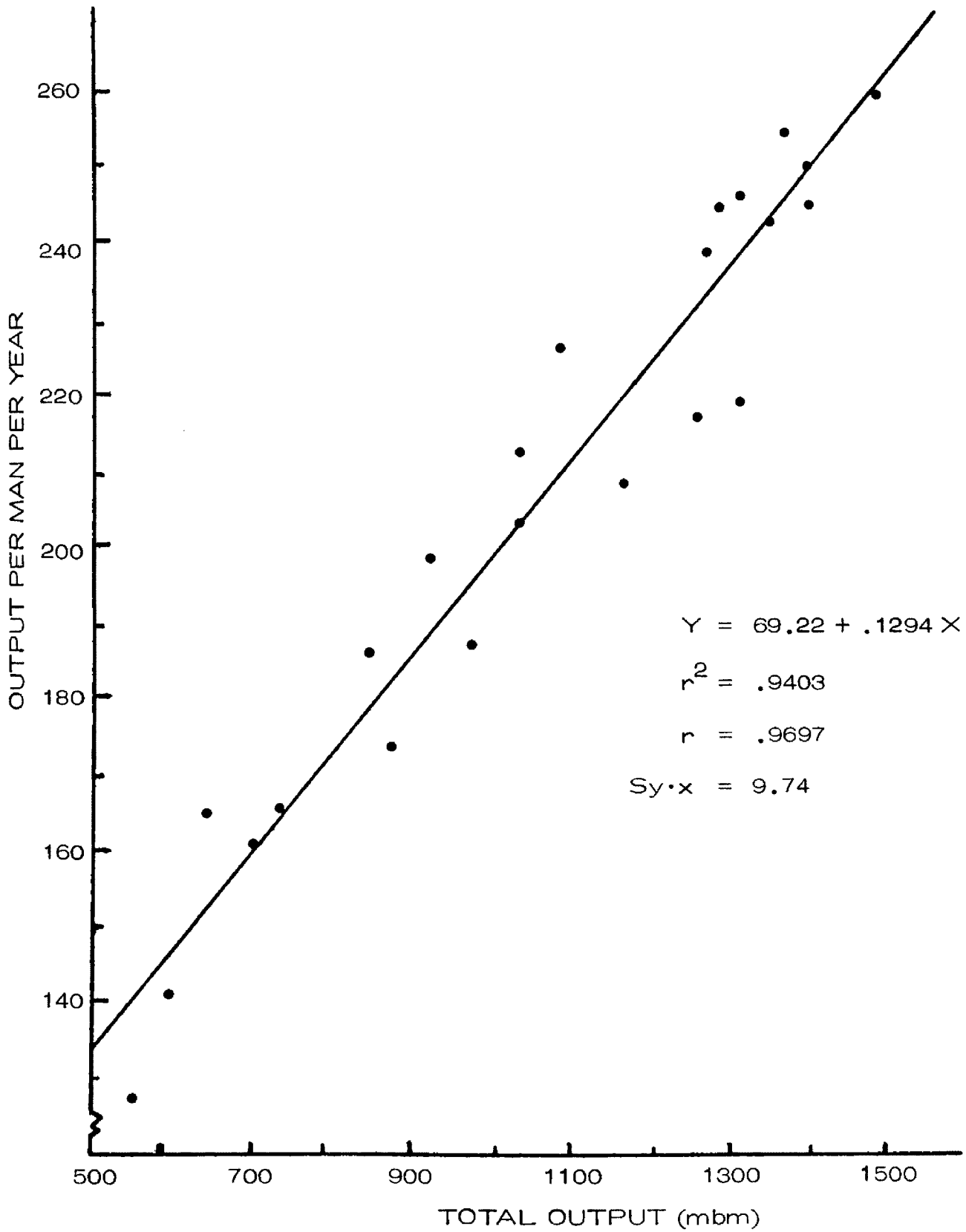
Other methods of projection may be more accurate than the one used in this discussion but the magnitude of past variations still would leave their accuracy in doubt. There is no reason to believe that these variations will not occur in the future and without an explanation of what causes their occurrence, projected productivity levels are susceptible to large error. The relationship between the productivity of all wage and salary workers and total production noted earlier in this presentation will now be discussed in greater detail to determine its usefulness in explaining the occurrence of past variations.

As a Function of Total Production

The data presented in Table 20 were plotted in Figure 12 in an effort to determine the extent to which productivity and total output are related. A linear regression model was fitted to these data resulting in an r^2 of .94. This means that 94 percent of the total variation in productivity may be attributed to changing levels of production, provided that there is actually a cause and effect relationship between these two variables.

There is substantive reason to believe that such a relationship does exist. The balance of production processes in

Figure 12. Relationship between productivity of all workers in the lumber sector and the total output of lumber.



sawmills and planing mills is such that there is imperfect divisibility of inputs when expanding or decreasing total production. At output X the labor input of a firm may consist of six units of non-production labor and twenty units of production labor. As production of the firm increases from X to 2X, labor input need not double in both categories. One example of this property has occurred often in the past when production in the aggregate for this sector increased and many mills expanded their operations from one to two and sometimes three shifts per day. The increase in non-production workers in this case is often less than proportionate to the production increase. Secretarial staff may only need to be increased from two to three secretaries. The marketing staff may not need to be increased at all because of a decrease in the effort necessary to sell lumber during good market periods. Similarly, a decrease from two shifts to one will usually result in a decline in productivity. Several of the managers of efficient Montana mills confided in the author that they were on the verge of reducing the number of shifts due to poor market conditions and that the productivity of labor in their mill would consequently decline.

Another factor which would cause productivity to be dependent upon production levels is the outlook of the mill owner or manager at the time the mill was established. Growth was a

prominent characteristic of this sector since 1950. A mill owner anticipating that growth and wanting to share in it would likely opt for a mill designed to operate more efficiently at production levels slightly higher than realistically expected during the first few years of performance. As total lumber consumption expanded in this country Montana mills were able to increase their production to the levels originally anticipated enabling them to achieve higher productivities. A log debarker for example, may be capable of debarking enough logs in one shift to satisfy the requirements of the mill for two shifts or a planer may be able to plane the output of two shifts in one shift.

There are many other possible explanations of why productivity is related to production, but hopefully the ones reviewed are sufficient to affirm a cause and effect relationship between the two variables. The interpretation of the importance of this relationship, relative to technology, in determining productivity levels now invites attention.

Technology, per se, has apparently not been the limiting factor in the levels of productivity achieved to date. Rather, the level of total production of this sector appears to have had an over-riding influence on productivity accomplishments. To the extent that this relationship remains viable in the future, the anticipation of total resources available in a given year coincident with prevailing

market situations, would seem to provide a much better indication of future productivity and employment in this sector than the determination and extension of productivity trends.

Discussion

Future employment in the sawmills and planing mills of Montana has been estimated by two different methods: 1) as a function of the projection of productivity trends and 2) as a function of the relationship between production and productivity. After reviewing the relatively large variations that occurred in past productivities in relation to a minor average increase in productivity, the estimation of the future productivity levels based on average increases in the past appeared to be subject to large errors in accuracy. A definite relationship existed between production and the productivity of all workers in this sector which seemed to account for much of the past variation in productivity, but we have no assurance that it will be applicable in the future. The most credit that could be imputed to the role of technology in the large productivity changes experienced by this sector was that it did not appear to be a limiting factor in the enhancement of productivity levels.

We must look at possible changes in agents capable of modifying the relationships discussed if we are to gain a better grasp of: 1) future employment levels in this sector, 2) the applicability of total production as an estimator of those levels, 3) and the role of

technology in those levels. These agents include timber availability, lumber consumption, technological capabilities and log sizes.

Timber Availability and Lumber Consumption

In the past, mill owners in Montana shared in the growth of national lumber markets by increasing total lumber volume produced. As private sources of timber became inadequate to meet the raw material requirements of the industry, the U.S. Forest Service became the largest supplier of timber in Montana. The end of the U.S. Forest Service responsiveness to increased industry desire for timber is now visible as the gap between the annual sale of timber from this source and annual allowable cut on those lands narrows.

A U.S. Forest Service study (1971) found that the area of the timber growing base in each of six national forests considered had been over-estimated in prior inventories by 11 to 40 percent.[1] A portion of the Lolo National Forest, the only one in Montana considered, was found to have over-estimated its base by 18 percent. Most of the land removed from the timber growing base was characterized by low timber growing potential and so the reduction

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[1]U.S. Department of Agriculture, Forest Service, Stratification of Forest Land for Timber Management Planning On the Western National Forests, by J. H. Wikstrom and S. Blair Hutchison, (Ogden, Utah: Intermountain Forest and Range Experiment Station Research Paper, INT-108, 1971), p. 13. Timber growing base as used here refers to forest land suitable and available for timber growing.

in the allowable cut will be somewhat less than 18 percent. The Forest Service is still in the process of re-evaluating the timber growing base and the annual allowable cut for its lands in Montana and so final estimates are not available.

A decline in the volume of timber available from the Forest Service may cause repurcussions which reverberate throughout the industry and the state. The possibility of a decline in the upper limit of timber volume available for sale by the Forest Service in Montana was of sufficient concern to justify a study of the potential economic impacts of various levels of reduction in timber sale volume from this source.[1]

Whether or not there is a decrease in volumes from these lands, there is little room in which to increase lumber output in proportion to projected increases in consumption with existing utilization standards and management practices. Projected medium increases in lumber consumption are estimated to exceed 1970 levels by 30 percent in 1980, by 48 percent in 1990, and by 50 percent in the year 2000.[2] If the growth of lumber consumption

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[1]Johnson, "Wood Products in Montana", Montana Business Quarterly 10, (Spring, 1972).

[2]National Commission on Materials Policy, Timber: The Renewable Material, by Edward Cliff, (Washington, D.C.: Government Printing Office, 1973), p. 2.19.

actually approximates the predicted levels, Montana in order to share in that growth must obtain or utilize more wood fiber per acre than at present.

When the increasing production of Montana sawmills and planing mills exhausts the existing surplus in timber supply, several things of interest will happen. First of all, Montana will not be able to share fully in the anticipated growth of national lumber markets unless forest management practices are intensified and/or utilization standards are further improved. Secondly, competition for the available timber supply will increase and many of the less efficient mills will no longer be able to continue operation.

The Forest Service recently reduced the duration of timber sale contracts from a five year period to a two year period which served to further aggravate timber supply problems. Many mills in the past used the volume of timber under contract as security to obtain bank loans necessary to modernize mills. The security afforded by a two year timber supply is simply insufficient to obtain many bank loans.

Mills which are unable to maintain an efficient operation in times of increasing competition will go out of existence. Plants owned by large corporations appear to be in the most comfortable position from a standpoint of increased competition and financial foundations and as such are likely candidates to increase their share

of total lumber production in the future.

Throughout this discussion, future lumber production greatly in excess of previous peak levels has not appeared to be a likely possibility. The estimation of future productivity levels would not have to be extrapolated far from the base data presented in the production productivity model. At this point in the discussion, the use of this model to estimate productivity remains a viable tool.

Log Sizes

A gradual movement toward smaller logs, noted in an earlier discussion, should eventually result in a reduction in the range in size of logs that a mill must anticipate to use in manufacture. Flexibility in the sizes of logs used in a mill can only be attained at the cost of reduced efficiency.[1] More uniformity in log sizes will allow increasing specialization of equipment used to reduce logs to lumber with an increase in labor productivity. Less labor will also be required to sort logs prior to manufacture.

The possibility of increased efficiency resulting from smaller logs is a direct reversal of the effect that this trend was thought to have had upon labor productivity in the past. Instead of

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[1]See John Zivnuska, "National Forest Timber Sales: Alternative Approaches to the Problems of Today and Tomorrow", Forest Industries 90(7), p. 41; George Stiegler, "Production and Distribution in the Short Run", readings in The Theory of Income Distribution (Longon: George Allen & Unwin Ltd., 1950), pp.129-130.

introducing a new input (smaller logs) to a technology designed to handle an old input (larger logs), the industry will now be matching new technology to new inputs. The consequence of this process should be an increase in efficiency which is independent of total lumber production in the sector. The possibility is a hint that perhaps future productivity levels will move away from the rigid control exercised by production in the past.

Technological Advances

In our earlier discussion, we found that twelve mills in Montana responding to interviews in the study were characterized by labor efficiencies which exceeded the 1972 average for all Montana mills by slightly more than 50 percent. The most efficient of these mills actually exceeded the state's average by 87 percent. Other mills in Montana surely will not be able to continue to operate with less labor efficient equipment when labor costs constitute such a large part of operating budgets and especially in times when competition for logs is increasing.

Technology which is more efficient than any found by the author in Montana does exist and may soon become adopted in this state. One such mill in Oregon is capable of producing 35 thousand board feet per eight hour shift, utilizing only four production workers and as a bonus, converting approximately twice as much lumber from each log than indicated by the scaled volume (subject to local

log scale rule and growth conditions).[1] In terms of output produced in one hour by a production worker, this mill averages over seven times the 1972 average for all Montana mills. One mill in Montana has much of the same basic equipment including adjustable multiple saws with a computer scanner to determine and set the logs and saws in positions which yield the maximum amount of lumber. Two other mills interviewed in the study were considering similar types of investment.

We can expect future productivities to increase almost independently of output in the sector based on the existence of new technologies which are just coming into their own. Poor lumber markets would still probably cause lower rates of technological infusion into the sector just as they appear to have done in 1974. Once most of the basic types of new technology has been installed perhaps we can expect a new relationship to evolve between production and productivity.

Final Projection of Employment Levels

Our discussion in this chapter has covered many facets of problems surrounding the prediction of future productivity and

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[1] "Automated Studmill Reaps 100 Percent Overrun", Western Timber Industry, (Miller Freeman Publications, October, 1974), p. 22. (The disparity between scale volume and lumber output may have been due to the log scale used and the timber growth conditions.

employment levels in the sawmill and planing mill sector. No one facet was found to yield comfortable estimations, and so we are left slowly backing out on a limb with little visible means of support in an effort to estimate future productivity levels. These estimations cannot be made relevantly for general employment levels in a particular year because of the impact of variable factors such as lumber production, lumber market and timber supply. We shall instead reference estimations of labor productivity to one arbitrarily chosen year (1985) which should allow sufficient time for many of the factors discussed to enact their probable roles.

Many of Montana's sawmills eleven years hence (1985) will be much more automated than they are today and will probably be patterned after today's more efficient mills such as the one in Oregon discussed above. By 1985, these types of mills should have proven themselves to be a good investment to many skeptical mill owners in Montana. In addition, log sizes should be more uniform by that time and of a size more appropriate to the design of this kind of mill.

The general market outlook should be much more favorable than today. An increasing number of purchasers coincident with an increasing population should provide increased lumber consumption, even if per capita consumption decreases. Many substitutes, notably aluminum, will have lost part of their market share to wood because

of the relatively high energy inputs necessary in their manufacture as well as their greater impacts on the environment. Research cited by D. F. Flora[1] indicates that an aluminum construction component requires 20 times as much energy to manufacture as a similar wood component and that while 3.4 tons of wood residue is left in the woods for every ton of round wood produced, 1 ton of aluminum ingot requires 9.2 tons of overburden and tailings plus 6 tons of raw material.

The productivity of all workers in Montana's lumber sector is likely to exceed 1972 levels by approximately 114 percent in the year 1985. To arrive at this estimate, the ponderous assumption was made that relative differences between increases in the productivity of production workers and increases in the productivity of all workers which occurred from 1959 to 1972 would be maintained into the future. The relative range in 1972 productivity levels between the most efficient mill and the average for all Montana mills was also postulated to remain constant in 1985. Admittedly, there is much room for possible predictive error created by these hypotheses, but they still allow us to improve our comprehension of the possible future effects of technological advance on labor productivity. In 1972, the average productivity in Montana mills

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[1]Donald F. Flora, "Timber as a Strategic Resource", Journal of Forestry, (July, 1973), p. 396.

was only approximately one-half the productivity of the most efficient mill found in the study. While the best possible productivity estimate (of production workers) for 1985 would equal approximately 800 percent[1] of the average efficiency in Montana today, Montana's sawmills would only be able to boost their average production worker productivity level 400 percent, or by one-half the best possible. A 28 percent increase in the productivity of production workers in sawmills between 1959 and 1972 corresponded to an increase in efficiency for all sawmill workers of only 8 percent, roughly a 3.5 to 1 ratio. The division of the 400 percent predicted gain in productivity among production workers by 3.5 yields a 114 percent increase in productivity for all workers in this sector.

A 114 percent increase in productivity would mean that the sector could produce 470 thousand board feet per man per year, more than double the 1972 levels of 219.5 thousand board feet. At 1972 production levels, less than one-half the number of workers employed in 1972 would be required to produce the same output in 1985.

Despite the weak points in the hypotheses of the preceeding analysis, it should be apparent that tremendous productivity increases in the near future are not only possible, but they are

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[1]This increase would correspond to the capability of the mill in Oregon discussed earlier.

imminent as are ultimate decreases in employment in this sector. National consumption of lumber was estimated to increase only 39 percent by 1985 and even if Montana shares fully in that increase, employment in this sector would still suffer a substantial reduction. Regardless of production increases, we can foresee no way in which 1985 employment in the sector will exceed 1972 levels. The major agent in substantive and dynamic productivity changes in the sawmills and planing mills of Montana will be the application of new technology.

CHAPTER 6

SELECTED MOVEMENTS IN MONTANA'S WOOD PRODUCTS INDUSTRY

Future production and utilization levels achieved in the individual wood product sectors may have a substantial impact upon the distribution of economic benefits among participants. A decline in the production of a sector, for example, may result in the complete loss of that sector and its associated income and employment to a community. Production and utilization increases on the other hand may coincide with the construction of mills in communities and an increased demand for various forms of wood fiber.

This chapter will be devoted largely to the brief discussion of non-quantitative aspects of possible changes in production and utilization levels in individual wood product sectors. A great deal of effort was expended in Chapter Four attempting to describe future quantitative employment levels in the sawmill and planing mill sector. An attempt to describe future employment levels for other sectors for which there is even less information would resemble an effort to inflate a balloon with holes in it without first patching the holes.

Expansion or Contraction

The Indications

The growth of an industry is dependent upon at least two conditions. These conditions are as follows: 1) there must be sufficient demand to encourage firms to increase production, and 2) there must be enough raw material to support an increase in production. Montana has the raw materials to expand production in at least some of the sectors, but we are not well informed about the future demand for wood products.

The best available indication of future demand for wood products appears to be a study by Cliff.[1] That study (using 1970 prices) projected future consumption as a function of the demand for aggregated individual end-uses for wood. The major wood product sectors discussed in this paper are all expected to participate in consumption growth during the next thirty years (Table 24 and figure 13). The total consumption of particleboard and paper and paperboard were projected to rise 172 and 170 percent respectively above 1970 levels by the year 2000. Plywood and lumber are expected to increase 107 and 58 percent respectively above 1970 levels during the same period.

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[1]National Commission on Materials Policy, Timber: The Renewable Material, by Edward Cliff, (Washington, D.C.: Government Printing Office, 1973).

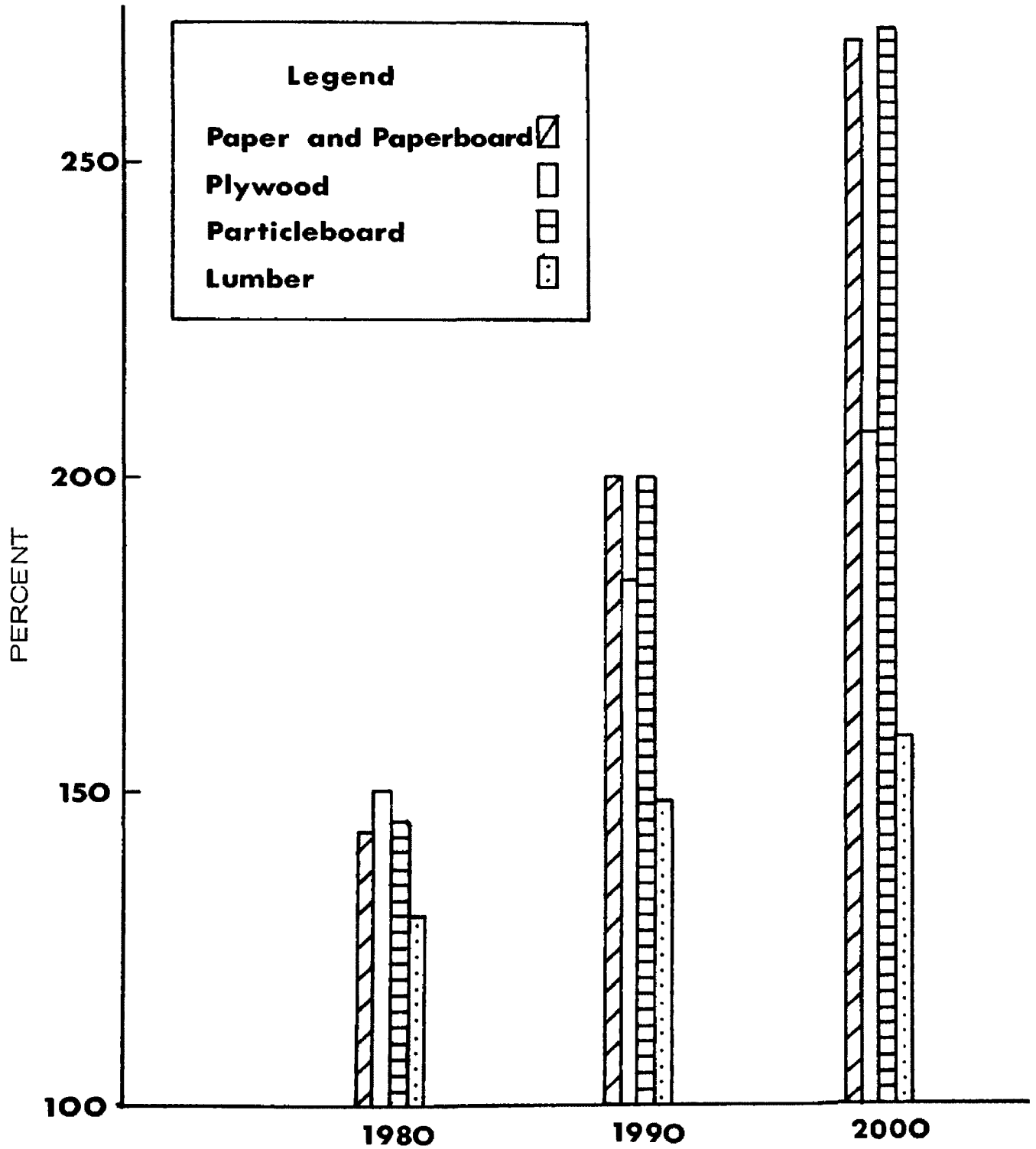
TABLE 24

PROJECTED "MEDIUM INCREASES" AS A PERCENTAGE OF 1970 LEVELS FOR THE PAPER AND PAPERBOARD, PLYWOOD, PARTICLEBOARD AND LUMBER SECTORS

Year	Paper & Paperboard	Plywood	Particleboard	Lumber
1970	100	100	100	100
1980	143	150	145	130
1990	200	183	200	148
2000	270	207	272	158

Sources: Derived from National Commission on Materials Policy, Timber: The Renewable Material, by Edward Cliff, (Washington, D.C.: Government Printing Office, 1973), pp. 2.19, 2.20, 2.23.

Figure 13. Projected changes in consumption of various wood products in the United States as a percentage of 1970 levels for the years 1980, 1990, 2000.



Increases in consumption of the suggested magnitude would necessitate corresponding increases in the volume of raw material and the redistribution of wood fiber among the sectors (see figure 14). Timber consumption would increase from 11.6 to 22.3 billion cubic feet. Wood volume utilized as sawlogs is projected to decrease from 47 percent of the 1970 total to 39 percent in 2000. Pulpwood and veneer logs are projected to increase their share of total wood consumption from 35 to 46 percent and 9 to 11 percent respectively.

The projected national consumption of wood products, however, does not seem applicable to Montana. The state has not followed national trends in the past; slightly more than 70 percent of the total fiber used in 1969 products in Montana was sawlogs.[1] The 33 percent difference in the proportion of total wood used as sawlogs between the nation and Montana leaves little reason to believe that these two will follow similar growth patterns in the future. Several Montana sectors have increased already their capacity by greater percentages than the predicted increases in the 1980 national consumption. Particleboard production capacity recently increased an estimated 69 percent above 1970 levels, with the addition of a new plant owned by Plum Creek Lumber Company

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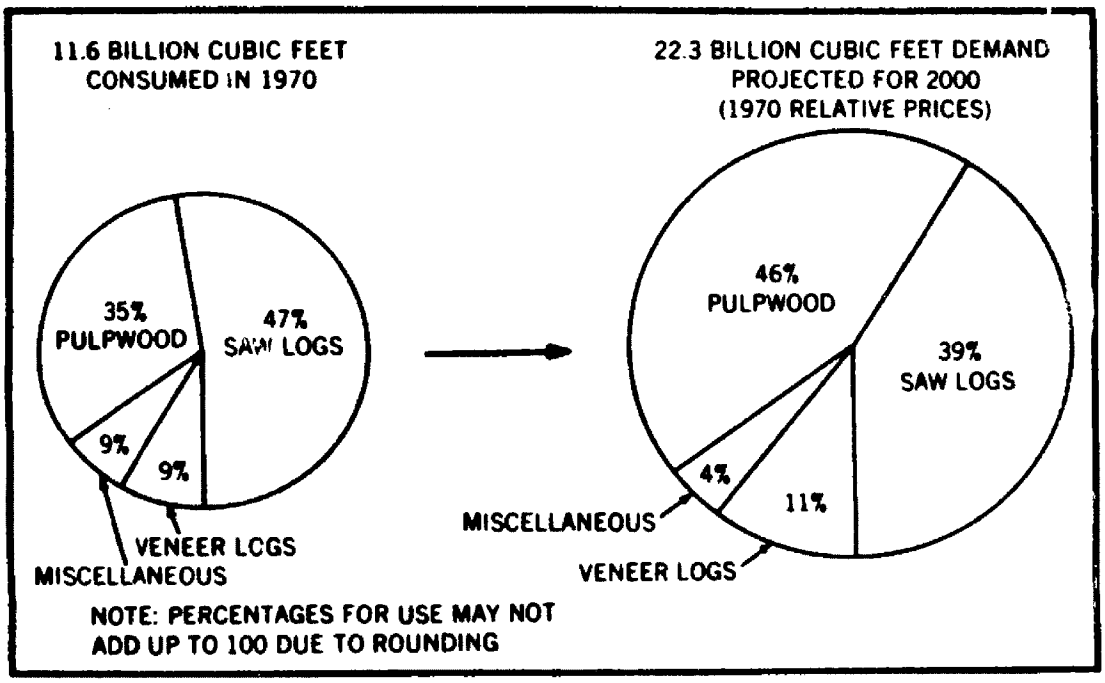
[1]National Commission on Materials Policy, Timber: The Renewable Material, by Edward Cliff, (Washington, D.C.: Government Printing Office, 1973), p. 2.15.

Figure 14. Trends in national demand for timber.



U.S. demand for pulpwood, saw logs, veneer logs, and miscellaneous wood products projected to the year 2000, assuming 1970 relative prices.

Source: National Commission on Materials Policy, Timber: The Renewable Material, by Edward Cliff, (Washington, D.C.: Government Printing Office, 1973), p. 2.15.

(Burlington Northern,1974).[1] Plywood production capacity was boosted approximately 65 percent above 1970 levels with the addition of the new mill at Bonner (U.S. Plywood, 1973).[2] Increases in the national consumption of particleboard and plywood for 1980 were estimated at 45 and 50 percent respectively. The prediction of growth in Montana's wood products industry using national consumption trends as a base is not possible because there is no apparent direct relationship between them. The discussion of locational aspects of the sectors, therefore, will include both expansion and contraction possibilities.

Locational Aspects

Probable future locations of product sectors are of interest especially in communities which derive large proportions of their income from one or more sectors. We shall view both the possibility of increased production and decreased production and attempt to cite probable locations of subsequent activity.

Expansion

Mills with latent headsaw capacity will be in the best position to increase production in times of expanding lumber

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[1] Figures derived from Directory of the Forest Products Industry, 1972, (Portland, Oregon: Miller Freeman Publications, 1972).

[2] Ibid.

markets. Excess headsaw capacity with respect to the annual allowable cut is not an uncommon occurrence in Western Montana.[1] The addition of new mills would not be expected because of the ability of many existing mills to expand their production. The extent of over-capacity, however, may have declined in recent years. Sixteen mills interviewed in the study produced 695 million board feet in 1972 and had a total headsaw capacity of 834 million board feet (basis of capacity was 240 days per year and two eight hour shifts per day). The mills could absorb only a 17 percent increase in production above 1972 levels without making substantial changes in their physical plant capacities.

The apparent inability of existing mills to accommodate production increases beyond 17 percent leaves the location of future capacity expansion in doubt. Distance from the raw material source would likely be a more important factor in location than distance from market because freight costs of lumber shipped by rail to major exterior markets are similar for most areas in Montana. A mill 60 miles from Missoula, for example, can actually ship its products to market cheaper than a mill in Missoula which depends upon the same raw material supply. Bark, chips,

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[1]Arnold W. Bolle, Robert Haring and William Gibson, The Economics of the Montana Forest Products Industry, (Missoula: Montana State University, 1964), p. 34.

shavings and sawdust from both mills come to Missoula, but the lumber is shipped to market from the outlaying mill by rail at the same cost as from Missoula. This allows the more distant mill to save the freight expense incurred by the Missoula mill which hauls the equivalent weight of the lumber still in logs an additional 60 miles. The location of the active sawmills in Montana were situated with these transportation costs in mind, so we can expect expansion in substantially the same areas.

A study of particleboard expansion found only one area in Montana which had sufficient uncommitted mill residues to support a particleboard plant.[1] This area, near Libby, appears to have enough residues to support a mill with an annual capacity of 90 to 100 million square feet which would employ approximately 125 people for full, three shift operations. The same study indicated that expansion of the particleboard sector in Montana using forest residues for raw material was unlikely in the 1970's.

The expansion of plywood capacity probably would occur near Libby or Columbia Falls. Plywood is dependent upon large, high quality logs for its existence and the best source of those logs is in areas of concentrated sawmill capacity. Sawmills are often

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[1]Richard Withycombe, "The Outlook for Particleboard Manufacture in the Northern Rocky Mountain Region", (rough draft, University of Montana and the U.S. Department of Agriculture, Forest Service Intermountain Forest and Range Experiment Station, 1974), p. 68.

willing to exchange their high quality logs with plywood mills for a greater volume of low quality logs which are present in timber sales purchased by plywood mills. Libby and Columbia Falls offer the largest concentrations of sawmill capacity in Montana today. Missoula was also a prime location for new plywood capacity but the addition of the large new mill at Bonner should utilize any excess volume of prime peeler logs which may have occurred here in the past. Eastern Montana lacks the concentration of sawmill capacity and the abundance of suitable raw materials necessary in the current manufacture of plywood.

The only probable expansion in the pulp and paper sector is in Missoula (Hoerner-Waldorf) where a 700 ton per day increase in pulp capacity is currently being considered. This expansion would create approximately 150 new jobs.[1] A study (1955) of possible pulp mill sites with respect to tolerable mill effluent in Western Montana streams found only one site (along the Clark Fork River below Plains) which could tolerate a mill with a capacity in excess of 400 tons per day.[2] The Missoula mill, however, deprived of a

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[1]Lloyd Berg, et. al., Summary of the Environmental Impact Statement on the Proposed Expansion of Hoerner-Waldorf's Missoula Pulp and Paper Mill, (Missoula, Hoerner-Waldorf Corp., n.d.),p. 5.

[2]U.S. Department of Agriculture, Forest Service, The Forest Resource of Western Montana, by Henry Pissot and Harold E. Hanson, Intermountain Forest & Range Experiment Station Resource Bulletin INT-1, (Ogden, Utah: 1963), p. 14.

large portion of its normal chip supply due to slumping lumber markets is currently hauling chipped forest residues from distances which blanket a good portion of the supply area in that location.

Contraction

Montana's wood product sectors may contract due to decreased markets or decreased availability of raw materials, but it is not possible to predict far in advance where sectors will curtail operations. The two situations may result in the closure of completely different mills and location need not be an overriding factor in either situation. The factors which cause the closure of a mill one time also may not cause a repeat performance in the future because of changes in the mill.

All of the sectors except pulp and paper are currently reeling under the blows thrust upon them by slumping markets for their respective products. The mills which have ceased production momentarily were unable to cover variable production costs on a reduced production basis. Location had little or nothing to do with their closing and changes may be made which will allow them to operate if the same conditions should re-occur in the future. We cannot predict which mills will close under similar future circumstances.

The closure of mills under conditions of expanded markets but restricted raw material supplies may be entirely different mills

than those that are presently closed. Closures under these conditions may be the result of any one or more of the following variables: location of the restricted raw material supply, variable and total costs associated with the output maintained, prices of products, financial support for the mill and the tenacity of the mill owner. The nature of these variables makes future prediction of the location of general mill closure highly improbable.

Utilization Movements

General Trends

Utilization of fiber in all sectors except particleboard is generally improving with good prospects for continued improvement in the future. Fifteen mills which produced approximately 50 percent of Montana's total 1972 lumber production all had at least one head saw which could profitably produce lumber from a log with a 6 inch diameter top. Nine mills claimed that they could profitably saw logs with a 5 to 5.5 inch diameter top and one mill was installing a saw that could profitably utilize logs with 2.5 inch diameter tops. The minimum size of log that mills are willing to accept, given the present range in capabilities may easily drop below 5 inch top diameters, especially if lumber prices increase, making small logs no longer marginal. Three plywood mills had minimum diameter standards for peeler logs ranging from 10 to 12 inches. This range demonstrates a possible improvement in

utilization standards among plywood mills down to at least a 10 inch diameter. The pulp mill in Missoula recently purchased several chippers at a cost of more than $5 million dollars to chip cull logs on a large scale in an effort to supplement the supply of chips from sawmills. The use of these chippers will probably be extended in the future even if the sawmills increase their chip production. An earlier discussion in this chapter indicated that particleboard plants would continue to use substantially the same mill residues throughout the 1970's.

Incentives

Mill owners were asked to suggest utilization incentives which they thought the Forest Service could extend to them. These remarks were directed toward the Forest Service because that agency manages the predominant share of commercial timberland in Montana. Most comments centered around the increased length of time for timber removal offered by contracts and improved operations in salvage sales. Management at the ground level of the agency perhaps can do little to alter the nature of these problems, but if the agency hopes to provide mill owners with incentives to improve utilization, they must take stock of the alternatives available as viewed by purchasers.

Most mill owners would like to have the recently shortened contract period lengthened beyond the present two year length.

Longer contract periods would allow mills to build up a surplus of stumpage under contract which could be used as security to obtain loans to invest in the improvement of mill utilization capabilities. Some mill owners also argue that timber is often left on the sale site which could profitably be reduced into products if additional time was allowed in contracts to wait for more favorable market conditions.

The Forest Service favors the two year contract largely as an administrative aid in controlling the conduct of loggers in timber sales. A partial answer to the problem may involve retaining the two year active time span of the sale but allowing mills to invoke the activation of the sale within a five year period.

Nearly all mill owners were unhappy with the current salvage sales made by the Forest Service. Extended time periods between stand mortality and the time of sale reduces the value of the timber to mill owners and results in additional volumes of timber residue left in the field.

"Green Slip" sales were once sold without bid to operators who wanted to remove recently dead trees in areas where they were operating. These sales were discontinued largely because of problems in making sure that the logger harvested only dead trees and problems developed with the equitable distribution of sales among purchasers. The latter problem could be circumvented by granting

salvage rights to timber purchasers on timber within the boundaries of the purchased sale. The former problem may be approached by marking individual trees and/or the felling of designated trees by fellers under contract with the Forest Service.

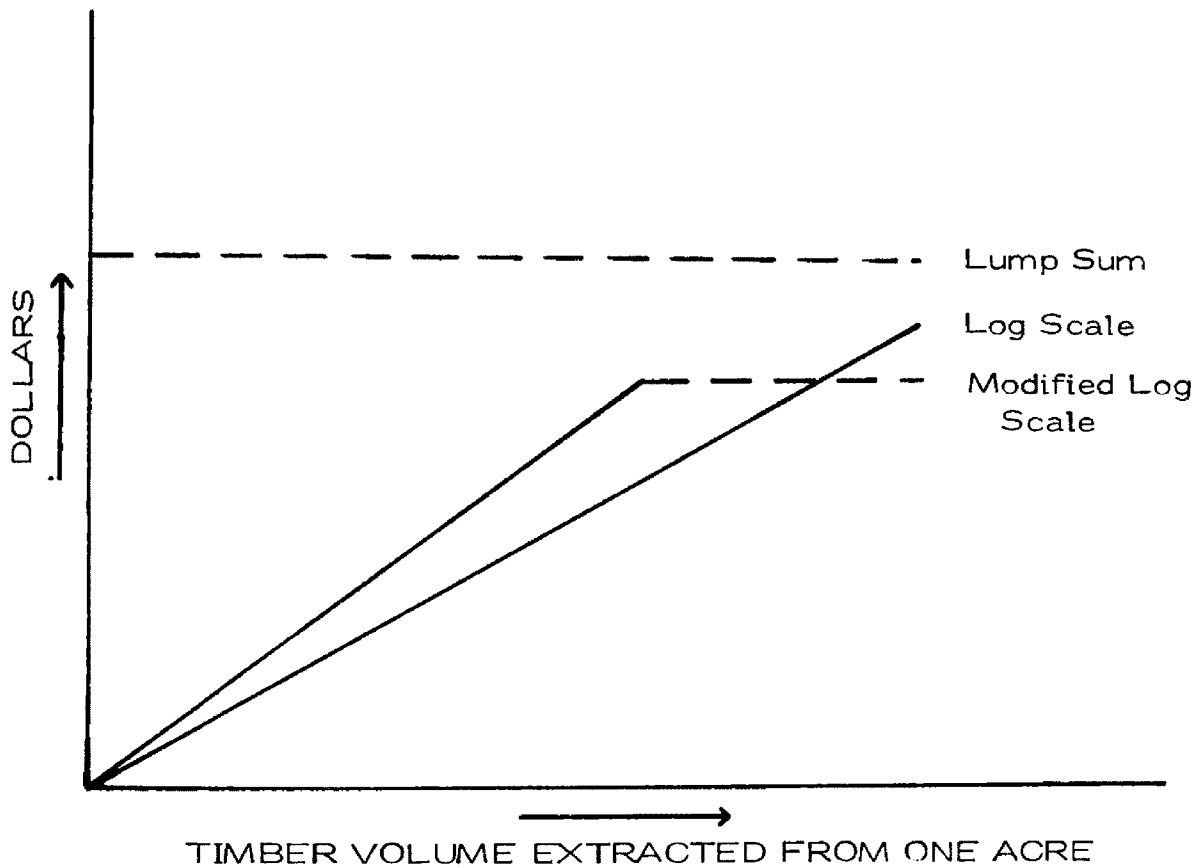
These problems do exist and do inhibit better utilization practices according to mill owners. The existence of these problems deserves the attention of the agency. If the Forest Service cannot resolve these problems, they could better communicate this information to mill owners.

Lump Sum and Log Scale Sales

Lump sum and log scale sales are two major different types of timber sales used in Montana which may influence utilization behavior. A price for a sale is agreed upon between the buyer and seller in lump sum sales and that price does not vary with the volume of timber removed from a sale. A price per unit volume removed is the basis for log scale sales and certain utilization standards are generally specified. Log scale sales are often modified by assessing perchasers greatly reduced or zero rates for volume contained in stems beneath specified utilization standards. The general form of the stumpage cost curves of each major sale type is shown in Figure 15.

Lump sum sales are often thought to encourage better utilization practices than log scale sales because the purchaser is

Figure 15. Basic form of total cost curves associated with major sale types.



not charged extra for marginal logs removed. Most mill owners interviewed did not believe, however, that a change to lump sum sales would influence their utilization behavior and thought that lump sum sales would only result in additional cruising costs to mills. Nautiyal and Love[1] did an excellent job of explaining the utilization initiative created by both sale types using cost and revenue curves (see figures 16 and 17). The author will use their basic technique with minor changes to further explore the use of the major sale types as a management tool in providing utilization incentive to mill owners.

The total revenue curve in Figure 16 is increasing steeply at first as only high valued large logs are sold. The marginal contribution to total revenue diminishes as lower value smaller logs are removed accounting for the flattening of the curve with improved utilization. Stumpage removal costs increase at increasing rates as more wood volume in an area is utilized because of increased costs associated with handling smaller materials.

The subtraction of the stumpage removal cost curve from the total revenue curve equals the possible net revenue curve of the timber purchaser (see figure 16). The purchaser's net revenue at

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[1]J. C. Nautiyal and D. V. Love, "Some Economic Implications of Charging Stumpage", Forestry Chronicle 41, (January, 1971), pp. 25-28.

Figure 16. Stumpage removal costs and total revenue.

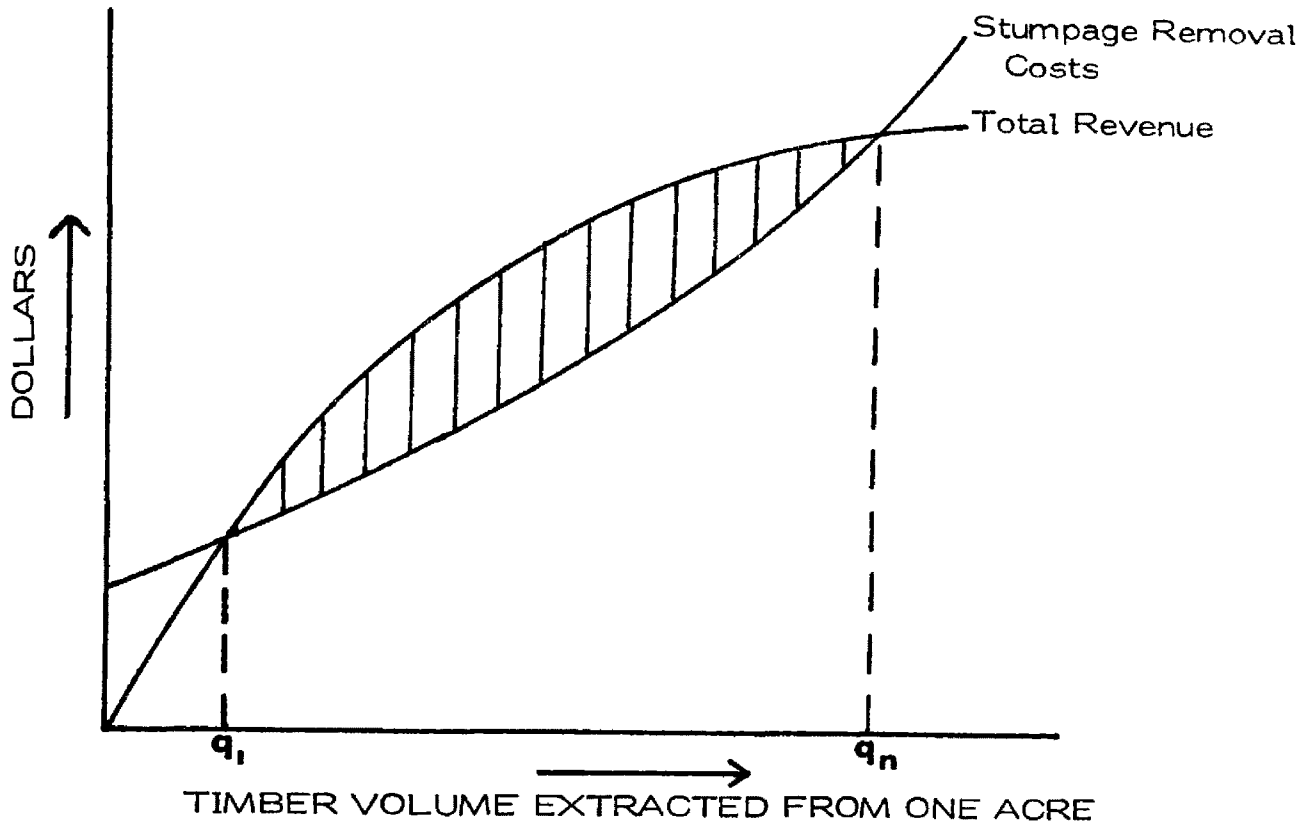
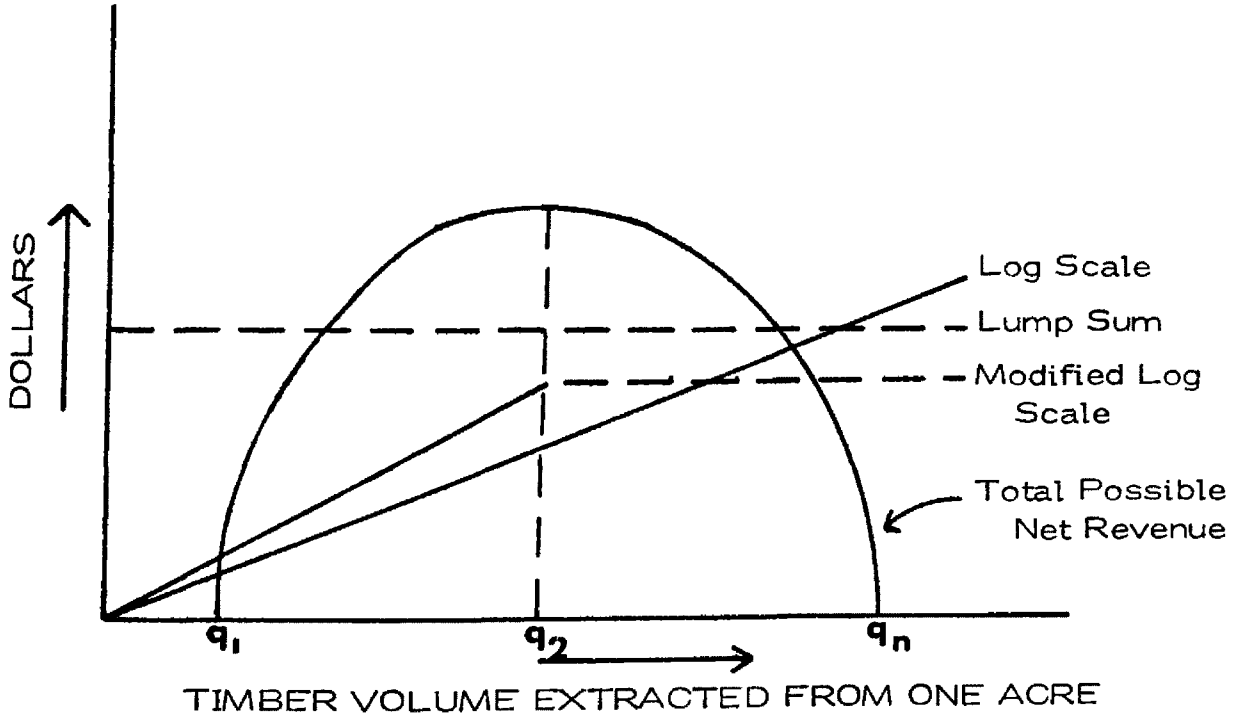


Figure 17. The effect of sale type on net revenue.



any given level of volume removed from a defined unit area will equal possible net revenue minus the price paid for stumpage. The purchaser optimizes his profits by paying minimum prices for the timber and by operating at a utilization level where the slopes of the stumpage price and possible net revenue curves are equal (the position of equality between marginal costs and marginal revenues). The slopes of the stumpage price curve varies with individual sale types which results in different utilization incentives with different sale types and prices.

An infinite number of possible situations similar to Figure 3 may exist for different firms, but this figure shows the basic nature of the influence that sale type may have on utilization. Lump sum sales will always yield equal or greater utilization than log scale sales without utilization standards (q_2 vs. some level of utilization between q_1 and q_2); the converse is not true. Intensive competition for timber drives stumpage prices up.[1] Higher prices do not affect the utilization level that operators want to achieve in lump sum sales (q_2), but cause operators in log scale sales to want

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[1] Clyde Fusick and George Sampson, "Price Behavior of Pine Pulpwood Stumpage from National Forests in Mid-South: 1955-1965", Pulpwood Production 14, March, 1966, pp. 18-20. U.S. Department of Agriculture, Forest Service, Competition for Federal Timber in the Pacific Northwest, by Walter Mead and Thomas Hamilton, Pacific Northwest Forest and Range Experiment Station Research Paper, PNW-64 (Portland, Oregon: 1968), p. 33.

to achieve lower utilization standards (movement towards q_1).

The timber seller will be able to improve utilization standards with lump sum sales better than log scale sales only to a level equal to the peak of the possible net revenue curve. The seller cannot effectively use either sale type to encourage the timber purchaser to operate willingly at a utilization level beyond the peak in the possible net revenue curve. Both sale types, at these excessive utilization levels, require the purchaser to operate in an area of absolute diminishing returns where no economically minded firm is willing to operate. Utilization standards required beyond the peak in the possible net revenue curve will also reduce the maximum amount of revenue which purchasers are willing to pay owners for their timber.

Lump sum sales are not a panacea to utilization problems, but they do appear to be a useful tool to the timber seller. The use of this sale type will consistently provide the seller with equal or better timber utilization than log scale sales if utilization standards are not applied. Neither lump sum nor log scale sales can be effectively used to improve utilization beyond the point of absolute diminishing returns to the purchaser. The application of utilization standards to lump sum sales in order to achieve such purposes results in lower timber prices and is economically irrational, unless the cost savings accruing to the owner (in terms of regeneration

and cleanup costs) exceeds the expected decreases in income.

CHAPTER 7

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the actual and probable impact of technological changes in the wood products industry on the economy and forests of Montana. This chapter provides a brief summary of information presented in the study and conclusions reached by the author based on that information.

Summary

Growth in per capita income and employment in Montana since 1950 has not kept pace with national averages. Montana's economy is expected to encounter further losses in national economic standing through the 1970's.

The wood products industry in the period following 1950, has proved to be a strategic component in the forces which elevated Montana's economy to its present level. The industry may be credited (directly and indirectly) with one-third of the total net increase in Montana's employment between 1950 and 1969. An estimated one-tenth of the total employment and personal income in Montana was attributed (directly and indirectly) to the wood products industry in 1969. The wood products industry was of

singularly critical importance to the economy of eight western counties accounting (directly and indirectly) for nearly one-half of the total employment and personal income (43 and 51 percent respectively) in 1969. The industry can be credited (directly and indirectly) with the creation of approximately two-thirds of the net new jobs in the eight counties. The stature and growth characteristics exhibited by this industry warrant concern for its future welfare.

Montana will never be a predominant timber producer in the United States, but her timber resources are sufficient to sustain an industry which is a vital fiber in Montana's economic fabric. Montana's borders surround approximately 6.6 percent of the nation's softwood growing stock which is situated on about 3 percent of the nation's commercial timberland. The public owns approximately three-quarters of that volume and as such has been vested with substantial powers of control over the life and future growth of Montana's wood products industry.

Increases in the annual cut of timber and improvement in timber utilization both appear capable of expanding the present timber supply parameters on a sustained even-flow basis. The annual allowable cut on U.S. Forest Service lands (the largest timber supplier in Montana), however, is being recalculated; and, preliminary indications point toward a reduction in the upper limit

of volume available from this source. All of the major product sectors in the industry appear capable of increasing their raw material supplies using a combination of one or more of the following: smaller log sizes, lower quality logs, and more of the existing residues.

The timing and magnitude of sector growth in Montana relative to growth in national wood product consumption is not clear. National consumption of most major wood products is expected to expand rapidly in the next thirty years. The plywood, pulp and paper and particleboard sectors have either installed or plan to install additional production capacities substantially in excess (on a percentage basis) of the predicted 1980 increases in national consumption of their respective products.

Technological innovation since 1950 in Montana's wood products industry has acted in a dual capacity. Such innovation has increased the useable volume of wood fiber from a given volume of timber and has decreased the quantity of labor necessary to manufacture a given level of output.

The pulp and paper and particleboard sectors (both of which were established in Montana after 1950) subsist entirely on wood fiber which formerly provided products of little or no use to man. Sawmills are now using large quantities of logs which would not profitably be converted to lumber in 1950 because of small size, and

or poor quality.

New technology or the different application of existing technology enabled each worker in the lumber sector to produce 34 percent more lumber in 1972 than in 1950. Production increases in excess of 34 percent were all that kept employment in this sector from declining during the period.

The future contributions of the industry to Montana's economy (in terms of employment) will be determined by the race between production increases and gains in labor efficiency. Prospects for increases in future lumber production increases in excess of productivity gains are dim. The particleboard, plywood and pulp and paper sectors are prime candidates to foster increased employment due to actual and probable expansion of production capacities.

Conclusions

1. Labor productivity and capital expenditures are indicators of technological change which affect employment but do not provide a measure of the magnitude of technological change in the wood products industry.

2. Projections of future productivity levels in the lumber sector based on averages of past occurrences are not reliable due to large productivity fluctuations in labor productivity in the past.

3. The large fluctuations in labor productivity in the

lumber industry appear to be explained largely by variations in production. Periods of expanding production were characterized by increases in productivity; periods of decreasing production were characterized by decreases in productivity.

4. Future labor productivities in the lumber sector will not likely conform to the model of production and productivity developed from data for the years 1950 through 1972. That model was the result of a relatively stable technology. Technology in this sector is now experiencing rapid innovation.

5. Sawmills investing in small log equipment have been richly rewarded in terms of labor efficiency. The average labor productivity in Montana sawmills and planing mills was well below the achievements attained in mills which invested in small log equipment.

6. Sawmills and planing mills have been important as a component and as a growth element in Montana's employment economy. This sector should remain as an important component in Montana's economic future but not as a growth element. Technological innovations now on the horizon are capable of boosting labor productivity in this sector higher percentages than forseeable production increases.

7. Many mill owners and managers think that the U.S. Forest Service can provide utilization incentives by lengthening

timber sale contract periods and by increased efficiency in salvage sales.

8. Mill owners and managers generally did not prefer lump sum sales to log scale sales.

9. Lump sum sales should always attain equal or better utilization than log scale sales when merchantability limits are not specified.

10. Utilization attained in lump sum sales should be recognized as the economic optimum by sellers and buyers in most circumstances. Enforcement of utilization standards beyond that optimum will likely result in reduced profitability to both the seller and the buyer.

11. Nearly all of the lumber production, and all of the plywood, particleboard, and pulp and paper production is produced by corporations.

12. The wood products industry has experienced much horizontal integration in recent years. All plywood mills are affiliated with the ownership of one or more sawmills. Owners of the two particleboard plants also own plywood mills and sawmills. The pulp and paper corporation owns several sawmills in Montana.

13. Large corporations are expanding their ownership of the total lumber production capabilities in Montana. Their share of total lumber production will probably continue to expand as new and

more efficient sawmill equipment is developed. Three of these corporations (St. Regis, U.S. Plywood, and Burlington Northern) seem to have easier access to greater quantities of internally generated money. These same corporations also own large acreages of timber which gives them the added advantage of a more stable timber supply.

14. Distance from the raw material supply appears to be the critical factor in the future location of expanding wood product sectors.

15. Mills currently closed in a situation of slumping lumber markets are not necessarily the most likely to close in the future under similar circumstances. The mills that are presently closed also provide no indication of which mills will close under conditions of expanded markets and relatively more restricted raw material supplies.

16. Basic assumptions must be made in order to predict future productivity levels. These assumptions are susceptible to gross error over time and figures obtained by using them are no less susceptible to error.

17. Montana may gain as many as 890 new jobs in the particleboard, pulp and paper, and plywood sectors from known actual, or known planned, or from probable expansion in the period from 1972 to 1985. These employment increases would be

apportioned approximately as follows: particleboard--probable 120, actual 110; pulp and paper--probable (proposed) 150; and plywood--actual, 500. These increases are highly speculative in part as even the actual expansions currently underway may not be entirely sustainable over the decade.

APPENDIX A

Introduction

Mill managers were the sole source of much information necessary to complete the study. The interview format was concieved as a tool to obtain this information in a concise and systematic manner. The format was developed in consultation with members from the following groups: forestry faculty at the University of Montana, U.S. Forest Service Researchers, and sawmill managers.

The comprehensiveness of the format may cause some readers to overestimate the information available from mill managers. Complete answers to all interview questions were seldom obtained. Many managers lacked records to provide some of the appropriate information. Other managers did not wish to divulge certain information requested in interviews.

The author thinks that more success may have been attained if the format had been shortened to several pages of the most essential questions. Lack of records pertaining to those questions would, however, still have inhibited the responses of many mill managers.

For the information of those who may so desire, the interview format is presented in this appendix.

ALL ANSWERS WILL BE KEPT CONFIDENTIAL

Mill Name _____

Mill Location: Town _____ County _____

Principal Mill Type: Sawmill ____ Plywood ____ Particleboard ____ Pulp & Paper ____

Individual type of Saws or Lathes[1]	Number

*Mill Characteristics	1960	1965	1969*	1972*
Production capacity per 8 hour shift (Mbf log scale and/or Mbm lumber tally)				
Average number of shifts per day				
Number of days operated				
Operating status-full time or seasonal				
Log Volume used (Mbf)				
Employment at mill (include all jobs performed after arrival of logs at mill)				
Wages and salaries paid employees considered above				
Investment in mill and mill yard (undepreciated)				
Property taxes				
Income taxes				

[1]Circular or band head saws, beavers, four or eight foot lathes, etc.

Volume of Products Produced and sold	1960		1965		1969		1972	
	Prod	Sold	Prod	Sold	Prod	Sold	Prod	Sold
Volume of sawn products (Mbm)								
boards (Mbm)								
dimension (Mbm)								
studs (Mbm)								
timbers and ties (Mbm)								
Chips (# of 2400 dry lb. units)								
Plywood (3/8" basis Mbm)								
Veneer (1/8" basis Mbm)								
Particleboard (½" basis Mbm)								
Poles								
Pulp								
Paper								

Drying status at Time of Sale	Percentage of Production			
	1960	1965	1969	1972
Kiln dried				
Air dried				
Green				

Energy Sources and Costs

2

Of the total heat used by this mill, kilns, etc., what percentage is produced from: wood residues ____, oil ____, gas ____, other (please specify) _____?

What was your total electricity cost for 1972_____? Of the total electricity produced and used by this mill, what percentage is produced by: wood residues ____, oil ____, other (please specify) _____? If external source of electricity was used, who provided it (REA, Montana Power).

Changes in Species Mix	Percentage of Total Log Volume Used			
	1960	1965	1969	1972
WLand DF				
PP				
LPP				
ES				
WWP				
WF and AF				
Hemlock and Others				

*Changes in Uses of Residues	1960				1965				1969				1972			
Percentages of the residue produced that is used for: heat = H, power = P, pulp and paper = PP, particleboard = PB.	H	P	PP	PB	H	P	PP	PB	H	P	PP	PB	H	P	PP	PB
Bark																
Coarse: slabs, edgings, trimmings																
Fines: sawdust, shavings																

*Capabilities of Individual Headsaws or Lathes, 1972. (Use separate blank for each item.)

Type of Lathe or Saw: _____	ES	DF	WL	PP	LPP	WWP	WF, AF	Hem
Most Profitable log to process								
length								
top diamter								
Smallest log processed without incurring cost greater than value of products								
length								
top diameter								
Largest log that can be processed	One figure for all species is sufficient							
length								
butt diameter								

Type of Lathe or Saw: _____	ES	DF	WL	PP	LPP	WWP	WF, AF	Hem
Most profitable log to process								
length								
top diameter								
Smallest log processed without incurring cost greater than value of products								
length								
top diameter								
Largest log that can be processed	One figure for all species is sufficient							
length								
butt diameter								

Do you buy or trade logs with mills of other ownership (yes, no)? If yes, please give the names of the other mills _____

_____

_____

Plant Ownership

Present

a. Type--Proprietorship ____, Partnership ____, Corporation ____.

b. Name of owner _____

Past - If plant has changed ownership since 1960, please give the following:

Seller's Name	Date Sold
_____	_____
_____	_____
_____	_____
_____	_____

What are your plans for the future?

Increase operations_____

Decrease operations_____

Discontinue operations_____

No change_____

Integrate_____

What types of incentives do you think could or should be supplied you, in order to improve your utilization of logs or trees (examples: longer contract periods, allocated timber supply, lower stumpage prices, etc.)

Investments in Mill Since 1960[1]

Kind of equipment installed	Date Installed	Purpose[2]	Reason[3]	Dollars Invested	Source of Money	Interest rate paid	Net job change

Planned Investments in Mill[1]

Kind of Equipment Installed	Purpose[2]	Reason[3]	Estimated Cost	Estimated change in jobs due to new equipment

1. investments considered should be larger than $10,000.
2. to increase utilization, efficiency and/or capacity.
3. to meet pollution standards or to improve profits or to improve competitive position.

Are you party to a cooperative agreement with mills of other ownership to invest in equipment in an effort to increase utilization of log residues (yes, no)? If yes, what is the nature of the equipment and the names of the mills involved.

_____

_____

_____

Would you be willing to enter into such an agreement, if an opportunity to do so existed which would be more profitable as a coop agreement than by yourself (yes, no)?

Have you processed logs which incurred costs greater than the value of their products (yes, no)? If yes, please specify the circumstances. _____

_____

_____

_____

_____

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